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AND
FOUR POST-LARVAL DEEP-SEA FISH

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NINETEEN NEW SPECIES AND FOUR POST-LARVAL DEEP-SEA FISH*

By WILLIAM BEEBE

(Figs. 8-31 incl.)

This is the first installment of descriptions of new forms of fish taken on the Bermuda Oceanographic Expeditions of the Department of Tropical Research of the New York Zoological Society. They were all taken within the eight-mile circle whose center is at 32° 12′ North Latitude and 64° 36′ West Longitude, nine and one quarter miles south-southeast of Nonsuch Island, Bermuda.

LIST OF SPECIES

*Contribution, New York Zoological Society, Department of Tropical Research, No. 367.

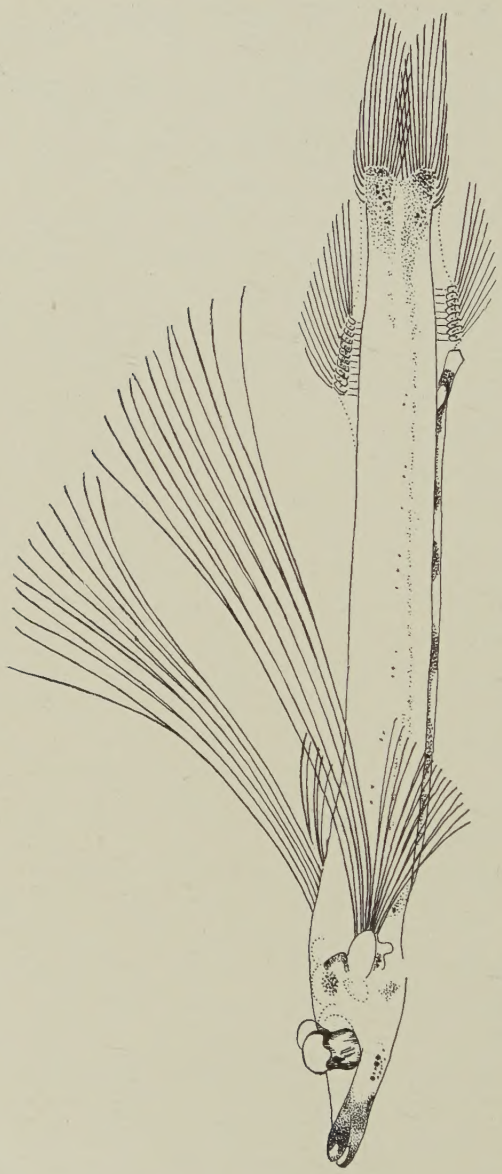

Fig. 8. *Dolichopteryx binocularis* sp. nov.

Dolichopteryx binocularis sp. nov.

Type: No. 21,867, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1125; *August* 4, 1931; 14 *miles southeast of Nonsuch, Bermuda;* 400 *fathoms; standard length* 85 *mm.*

Field Characters: An elongate, telescope-eyed fish, with very small mouth, exceedingly slender and elongate pectoral rays; scaleless except on lateral line, white and transparent above, with considerable dark pigment below: ventrals and vertical fins far aft on the body.

Measurements and Counts: Total length 101 mm.; standard length 85 mm.; depth 5 (in length 17); head 17 (in length 5); eye diameter 3.1 (in head 5.5); snout 7.1 (in head 2.4); mouth horizontal; eyes slanted 10° forward from the vertical; pectoral 6 + 8 = 14; pectoral length 55 mm.; ventral 3 + 6 = 9; ventral length 15; dorsal 15; anal 11; caudal XIII — 9 — 9 — XIV; caudal length 16 mm.

General Description: The fish as a whole appears as transparent white, with dark muzzle, five large, ventral blotches, and a midline of dark chromatophores.

The upper lip is white, the jaws solidly dusky, thinning into individual, black, round chromatophores back almost to the eyes; this pigment is close over the bone of the jaws, far beneath the outer, white, transparent skin; directly below the eyes are fourteen large, purplish, dendritic chromatophores, six in a straight row, the others in a bow shape below; on the side of the midbrain and back of the hind brain are solid masses of almost fused, black chromatophores; a large, triangular patch of many, very small ones over the lower angle of the gill arches; another large patch of disconnected ones directly over the heart which lies just below the pectorals; on the ventral surface are five dense patches of black showing purple glints; the fourth merges with the fifth far back beneath the ventrals; along the midline of the body a single row of iridescent or black chromatophores; these are arranged into successive groups, the more anterior of three to five chromatophores; from the midbody back the groups increase in number of components—five to ten—each group forming a short, oblique line, at a slight downward angle; midway between this line and the back is a second line of a very few, widely spread, large chromatophores, twenty-two altogether, quite irregular as regards spacing, two together or singly; from halfway between the end of the dorsal and the caudal the parallel-sided peduncle is thickly peppered with large and small, sepa-

rate, dendritic chromatophores, there being a clear space along the midline.

The body of the fish is elongate, with very little change in calibre throughout, the dorsal and ventral surfaces nearly parallel, the head narrows slowly into a broad, rounded muzzle, the eyes projecting well above the profile. The eyes rest in a great depression of the head, the upper part being covered with perfectly transparent tissue; the nostrils are round, close together, and about four-fifths the way to the snout from the eye; the eyes are very large, once and a half as high as wide, the stalk thick, short, dark, the summits clear, swollen and rounded; they are placed very close alongside each other, and slant forward 10° from the vertical; the eyeballs are overlaid on the front and outer side with longitudinal, prismatic, spicule scales, giving off blue, green and bronze reflections. On the outside the black of the eyeball extends upward in a rounded bay, which carries a large photophore, opening obliquely down and back in a silvery trough. The base of the eye-ball rests in a shallow saucer of silver spicules.

The mouth is very small, horizontal; the teeth are very indistinct in the uncleared specimen.

The dorsal fin arises high above the surface of the body, from a framework supporting an oval muscle and a tall baseost for each ray; forward the free skin stretches for a considerable distance, and posteriorly the high, free, transparent skin connects with the supra-caudal spines; the anal is similar in origin and the muscles of each fin have a scattering of black chromatophores along their sides.

The pectoral fins show a large, fleshy, basal pad, with a sharply oblique posterior rim, from which arise fourteen rays; the upper six are, in the fresh fish, directed straight back or slightly upward, and in this individual new-caught fish the first and sixth left rays and the first and third right rays were bent but still showed full length. They split into two about half-way of their length, and reached to half-way down the anal, or 55 mm. The lower eight were directed obliquely downward, showing a distinct break between the two, and were about equal in length, the largest being only 4.3 mm or one-fourteenth of the upper rays. The ventral rays reached the caudal and measured 15 mm.

The epidermis along the ventral surface from the gills to the anus is loose, well away from the body, suspended by numerous thread-like supports, carrying an opaque band of luminous tissue. The eye-light

is pale white; the ventral organ gleams only with the faintest sheen in the new caught specimen.

Dyed and Cleared: In the dyed and cleared specimen structures become visible which are unsuspected in the fresh or preserved fish. The most unexpected is a row of 48 lateral line scales extending from the opercle to the caudal. The first, just above the base of the dorsal pectoral rays, is a well-ossified, thick, half circle, opening backward. The next 26 are very small, thin, slightly ossified and irregular, some almost straight, others three-fourths of a circle. The 27th scale occurs at 18.6 mm. in front of the dorsal. From here on the scales increase in size and thickness, and become circular. At the 40th, just over the ventral fins, they reach their largest size, the diameter keeping even for the succeeding scales to the last at the very base of the caudal. These are .86 mm. in outside, vertical diameter with a central oval opening .5 mm. in length. From the 40th on, the posterior rim of the central opening shows a slight thickening of osseous tissue, which increases and concentrates toward the center until, in the 51st, a slight projection is visible. In the last five this extends clear across the central hole as a knob-shaped projection, and a low spine develops on the outside.

Anteriorly the scales are five or six of their diameters apart, but they gradually approach until posteriorly the edges slightly overlap. They are placed equidistantly between the row of isolated chromatophores, and the inferior, dense line. And now we see that each curve, or oblique row marks an individual scale, this being true even to the very first. The clear midline space in the pigmented peduncle is now explained, for it is quite filled up with the lateral line scales.

There is a second, incomplete row of scales, beginning between the 40th and 41st, and extending to the caudal. These are placed close beneath the oblique lines of chromatophores, alternate with the upper row, and are much smaller, almost round and solid. These round scales are smaller anteriorly and increase slightly in size backward. There is a short row of 5 scales, similar to these, above the line of scattered chromatophores extending a short distance along the sides from the opercles. All the scales are very delicate and deciduous, a few falling off at each change of fluid in the clearing process.

There is a row of about thirty, very small, close set, incurved teeth in the lower jaw. In the upper there are four to five rows of teeth. Externally, on the cleared, outer surface of the lips and jaw

the bases of these can be distinguished as separately ossified, mosaic-like, irregularly arranged crescents or kidney-shaped bony plates. Within the jaw each of these gives rise to a long recurved tooth, all lying flat in a solid mass against the roof of the jaw.

Of the eleven anal rays, only eight have ossified baseosts, the two anterior and the posterior ray lacking a bony support.

The fifteen dorsals show twelve baseosts, the anterior and posterior rays lacking them. The 2nd and 3rd show a single, high, thickened, anteriorly directed bone. The 1st ray is very short and the two lateral bases are not joined, standing erect as two short, curved, erect spines.

In the cleared tissue the nine ventrals are seen to be divided sharply into two divisions, six lower, very fine rays, close together, and three superior rays, placed farther apart and more than twice as stout as the others.

The luminous, ventral band of tissue along the free epidermis is now seen to have a large number of very small tubercles.

Discussion: In "Discovery Reports" Volume II, p. 271, Norman has considered the Vailliant's and Brauer's specimens, and the two taken on the *Discovery* as all belonging to one species—*longipes*. This can probably be decided with certainty only from cleared and stained specimens. The present individual is, in many ways, closest to the Discovery specimens, but is set apart by several characters, two of which will serve for specific distinction. The depth to the length is 17 instead of 12 and the pectoral fins are set apart into two divisions, the upper six of great length, reaching to the mid-anal, and the lower eight only one-fourteenth as long.

Chirostomias lucidimanus sp. nov.

Type: *No.* 22,200, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1157; *August* 10, 1931; 10 *miles south of Nonsuch, Bermuda;* 500 *fathoms; standard length* 225 *mm.*

Field Characters: A fusiform black fish with short, thick barbel, bearing a tri-lobed bulb, with various tentacles and beaded projections, the anterior being a group of five, 3/5 as long as the whole stem; pectorals six, threadlike, frayed out into numerous, fine, luminous tendrils; dorsal 16, anal 22.

Measurements and Counts: Total length 235 mm.; standard length 225 mm.; depth 36 (in length 6.2); head 37 (in length 6); eye 6.4 (in head 5.8); snout 10.7 (in head 3.45); pectoral 6; pectoral length 83; ventrals 7; ventral length 17; dorsal 16; anal 22; caudal length 10; barbel stem 25; anterior terminal filaments 15.

General Description: Dorsal and ventral profiles almost parallel, sloping rather sharply toward the rounded snout, and very gradually toward the abruptly narrowed and short peduncle; adipose fin well developed. In one-half of the upper jaw are two large anterior canines, the second much the larger; behind the second canine and outside it a series of five medium-sized teeth begins, wide-spaced and ending halfway down the jaw, all outside the dental line; just behind and in a line with the second canine, the normal jaw teeth, all evenly-sized, extend to the gape, ten in number. The arrangement and size of the mandibular teeth are identical with those in the upper jaw. Every tooth has its small understudy companion, waiting to take its place when need arises. The illicium bulb is blue-black, elongate and somewhat compressed. The terminal part projects as two large tubular divisions, each tipped with a pair of sharp, tooth-like structures opening toward one another. The uppermost has a few very short tubercles at the tip, but the lower one is tipped with a long, beaded, luminous tentacle, while from the ventral side, five long (7.1 mm.) tentacles spring from a single base. These under ultra-violet light give out a pinkish glow. The dorsal surface of the bulb shows a number of isolated spots of luminous tissue which consolidate into a thick, luminous, white comb, smooth and rounded, with a slender, distal filament. The luminous tissue (white glow on this area) dies out on the surface of the mid-bulb in an ever-thinning mass of scattered spots and dots.

There is at least a single muscle at the tip of the bulb which has the power of separating widely the two terminal structures, the four teeth-like structures showing up strongly through the translucent pink luminous tissue

Lateral line of photophores: O-V 23, V-A 19 (7 of these above anal); ventral line: I-P 9, P-V 25, V-A 19 (6 of these above anal), A-C 10.

Comparison: I have taken four specimens of this form in the limited area in which I am trawling, measuring from 38.6 to 225 mm. standard length. They approach, in many particulars, Regan's *pliop-*

terus, but the eye is smaller in *lucidimanus* being only three-fifths as long as the snout, and 5.8 instead of 4 to 5 in the head; the dorsal is 16 instead of 18 to 20 and the ventrals are a full fifth nearer the caudal than to the eye.

The details of the bulb and its distal tentacles differ in the same degree in my small as in my large individuals and the same applies to the pectoral fins. As a contrast I have one small specimen of 35 mm. which is typically *pliopterus* in all its characters.

The only other recorded specimens are seven taken by the Dana. These were secured at depths of approximately 40 to 273 fathoms, and measure from 33 to 115 mm. standard length.

Eustomias schiffi sp. nov.

Type: *No.* 15,653, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 646; *May* 29, 1930; *six miles south of Nonsuch Island, Bermuda; 600 fathoms; standard length* 115 *mm.*

Measurements and Counts: Standard length 115 mm.; depth 9 (in length 12.7); head 14.3 (in length 8); eye 2.7 (in head 5.3); snout 5.4 (in head 2.6); pectoral 2; pectoral length 16.4; ventral 7; ventral length 18; dorsal 23; anal 37; caudal VII + 26 + V; caudal length 10.7; barbel length 57 (in length 2).

General Description: The body is slender and elongate; the back is parallel with the ventral outline, sloping gently posteriorly; with the upper jaw retracted the anterior profile is deeply indented, there is a very steep curve in front of the eye, then a thick dermal wrinkle and a straight line to the snout; the head is short, shallow and flattened ventrally; the snout is elongate, retracted, with a deep roll of skin rolled up from eye to eye around the mid-snout, formed by the posterior edge of the premaxillaries; the eyes show considerable projection above the head profile; nostrils are close together, rather large, close to the antero-superior margin of the eye; the mouth is large and slightly oblique; the maxillaries extend well behind the eye.

Teeth: There are 14 teeth in each premaxillary, a larger and a shorter pair close together at the very tip of the snout, then a space, then a large pair of fangs, and the rest smaller and irregular. The maxillary has 18 very small, oblique denticles. In the mandible there is a median pair of small teeth at the sypmphysis, and a very large pair

at the antero-exterior angle of the front of the jaw, followed by 15 more teeth, four of which are moderately large, making 17 altogether on each side of the lower jaw.

Skin: Appears black to the eye, rich dark brown under the lens, covered with an infinite number of minute photophores in areas arranged more or less in regular bands or patches. There is the usual arrangement of larger light organs on the head and body; a round, suborbital cheek-light is .57 mm. in diameter, showing a silvery white light. The two rows of body lights are dark purplish violet. The photophores show the following counts:

Ventral I-P 8, P-V 32, V-A 15, A-C 18; lateral P-V 34, V-15.

Fins: The vertical fins are typical of the Eustomiads, concentrated toward the caudal end, the three forming a unified, and the only, means of propulsion; the pectorals are non-natatory and non-luminous, wholly tactile in function; each is reduced to two elongated rays, longer than the head, with a transparent vein down each ray, like a slender leaf; the ventrals are one and a third times the length of the head, and similar to the pectorals except that all are delicately bound together by webbing; the longest rays reach well beyond the beginning of the anal fin; the caudal has two unequal lobes, the lower of which is the longer; there are 26 functional caudal rays.

Barbel: This elaborate organ is half as long as the standard length of the body. The stem is very long and slender with a thin core rather thickly speckled with small, black dendritic chromatophores, and two lines of dull red—not veins—extending down its entire length. Anteroposteriorly the stem expands into a gradually widening transparent area, then into a retort-shaped bulb, pale brown on the anterior or lower surface. This color changes abruptly into brilliant peacock blue on the body of the retort, and this in turn into turquoise back along the neck. This neck of the retort is drawn out into a transparent, slowly narrowing process, filled with a few oblong luminous granules. This process gives off about fifteen long thread-like tentacles, each with a central, single line of granules. The tentacles are transparent, the granules of the palest, blue green. Just before the beginning of the neck of the retort, a thick finger-like tentacle arises from the upper or posterior side, ending abruptly, with no appendages. From each side of this part of the retort arise branched processes like the larger terminal one, one large one on the left side, three lesser ones on the right,

these breaking up in turn into three to eight elongate, transparent threads.

Scattered along the transparent sheath of the long barbel stem are oval bodies, lying against the outer surface and all faintly ribbed, indicated by a slightly greater density. At the very base is a swollen, elongated scarlet body lying close to the core.

General Discussion: In Regan's Key of *Eustomias* (p. 75)* he lists *dubius* as "One bulb bearing two minute filaments", including in this Parr's type which terminates in a mutilated or regenerated flattened, irregular fan of tissue. Next on the list is *polyaster* with the definition "A small bulb proximal to main one, which bears a branched terminal appendage with bulb-like bodies in the stem."

The general heading of these two species "Pectoral of two rays," and "Barbel with a bulb divided by a distal notch into two equal lobes, the larger tapering" admits the present specimen, while the proportions bring it close to *dubius* and the barbel to *polyaster*. It is, however, very obviously distinct.

Eustomias schiffi differs from *dubius* in having 32 ventral P-V photophores, not 34 — 36; the barbel is ½ the length of the fish, not 2/7 to 1/3; and the barbel filaments are wholly different. From *polyaster* it differs in possessing only a single bulb instead of two to four, in the smaller number of ventral P-V photophores, and in having 14 instead of 11 teeth in the premaxillary.

I have named this species in memory of Mortimer Schiff whose interest in the work of this expedition was very deep and sincere.

Lamprotoxus angulifer sp. nov.

Type: *No.* 21,667, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1108; *July* 27, 1931; 15 *miles southeast of Nonsuch;* 500 *fathoms; standard length* 145 *mm.*

Field Characters: An elongate, black melanostomid, with long anterior fangs, elongate barbel, a long luminous line extending down the sides with a short, downward, anterior hook; a second labial line from snout half-way down jaw, and a curved luminous line from eye around to mid-jaw. Pectorals five, three with luminous tissue.

*The Danish "Dana" Expedition, Report No. 6, 1930.

Measurements and Counts: Standard length 145; total 155; depth 18 (in length 8); head 25 (in length 5.8); eye 2.8 (in head 9), snout 4.3 (in head 5.8); mandible 22 (in head 1.1, in length 6.6); pectoral 5, pectoral length 7; ventral 7, ventral length 14.5; dorsal 21; anal 19 rays.

General Description: Body elongate, with rather straight, parallel contours, dorsal and anal fins far posterior, quite dominating and with much of the function of the caudal; head moderate with the usual enormous opercular opening of this group; a somewhat short, swollen snout, once and a half the diameter of the rather small eye; nostrils round, close together, nearer eye than snout; mouth large, jaws straight.

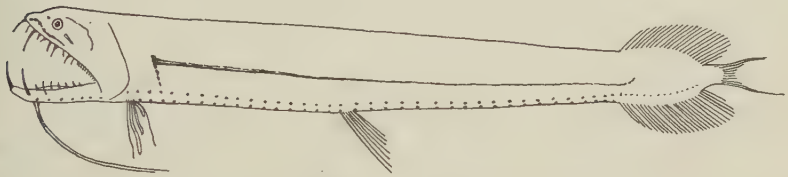

Fig. 9. *Lamprotoxus angulifer* sp. nov.

Teeth: At the tip of the premaxillary is a very long, strong pair of fangs, and following there is a line of five pairs of sharp teeth lying outside the dental ridge, the 1st and 5th twice as long as the others; along the ridge are ten teeth in each half jaw, the anterior pair very long. In front of the mandible is the longest pair of teeth to be found in the jaws. At wide, equal distances along the jaw are two more pairs of fangs, large and curved, all three pairs lying well outside the dental line. Inside of these are about fifteen teeth of varying size, scattered along each mandibular ramus. There are three pairs of small teeth on the palatines.

Skin: The skin is smooth, blackish brown, with the usual segments marked off by lines of black pigment.

The barbel is broken off at 13 mm. from the base, but was probably simple and of considerably greater length, as in *Lamprotoxus flagellibarba.*

Photophores: There is a moderate sized, narrowly pyriform, silvery cheek light behind the eye, 1.4 mm. in length, in a frame 2.4 mm.

long. The fish is covered from snout to tail with hundreds of very minute photophores pale pinkish in color, but like the larger ones in everything but size and regularity of position.

The lateral row of body photophores shows the following arrangement, O-V 16, V-A 22, A-C 12; the ventral ones I-P 7, P-V 17, V-A 19.

The lights on the branchiostegals are pale violet, those along the body deeper purple, with very large, concave gold caps.

Luminous Tissue: There is a very definite pattern of white, luminous tissue along the sides of the body in the shape of a long-handled, angled crook, the anterior part of which is formed by a solid line such as I have found in *L. flagellibarba*. The crook extends straight downward close to the posterior edge of the gill opening, breaking up into several, elongate spots toward the end. The handle extends down the midline, halfway the length of the anal. It consists of two divisions, a ventral, solid line for much of the distance, and a dorsal line, very close to it of small separate spots. The line becomes single at the level of the tenth lateral photophore beyond the ventral fin.

Besides this there is an almost solid line of luminous tissue from the tip of the snout down each side of the upper lip to a level with the middle of the eye, and a third, very thin, wavering but solid line arising back of the eye and curving back and down toward the anterior end of the maxillary denticles.

Fins: The vertical fins are not very high, and are concentrated at the far posterior end of the body. All are covered thickly with the dark body pigment. The dorsal and anal originate at the same vertical but, although the dorsal contains the greater number of rays, twenty-one, the anal is considerably the longer. Measured from the midline base of the caudal, the dorsal ends at a distance of 5 mm. and the anal of 9 mm. The caudal is small, deeply crescent-shaped, with the inferior lobe much prolonged.

The pectorals are placed very low and close together. They are short, wholly without natatory power, but greatly specialized as luminous organs. There are five rays, the 1st and 5th very long, thread-like and brown in color. The 2nd, 3rd and 4th show the same thin line of brown pigment but extending along their full length is a thick column of white, opaque, luminous tissue. The 1st, 2nd and 5th rays are equally long, 7 mm., but the remaining two are shorter.

The ventrals are pigmented, well-developed, consisting of seven rays, which however, are too filiform to be of much use in steering or progression.

A second specimen of *Lamprotoxus angulifer* was taken three weeks after the first; No. 22,483; Net 1187; August 17, 1931; twelve miles southeast of Nonsuch; 400 fathoms.

This fish is one-fourth as long as the first, but shows all the characteristics of the genus and species; standard length 33.6 mm.; head 5.7 (in length 5.9).

The fish was badly mutilated, the entire body cavity being torn open, but only the ventral photophores were injured beyond count; the fangs, the pectorals with their rays thickened with luminous tissue, the position and character of the ventrals, the long lateral line of luminous tissue along the side of the body, bent sharply downward close to the gill-opening, all confirm the validity of the species.

Discussion: This fish is close to *Grammatostomias dentatus* especially in number of pectoral rays, but differs decidedly in the much smaller eye relative to the head—5 in *Grammatosomias,* 9 in *L. angulifer* —and in the presence of the cephalic and somatic luminous patterns. This elaborate, lateral, light tissue is less developed in extent and wholly different in pattern, but directly related to that in *L. flagellibarba.*

Leptostomias bermudensis sp. nov.

Type: No. 20,826; *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1015; *June* 15, 1931; *7½ miles southeast of Nonsuch; 500 fathoms; standard length 285 mm.*

Measurements and Counts: Total length 297 mm.; standard length 285 mm.; depth 18 (in length 15.8); head 26 (in length 11.0); eye 4.3 (in head 6.0); snout 11.4 (in head 2.2); maxillary 15 (in head 1.7, in length 19.0); pectoral rays 12; pectoral length 12; ventral rays 7; ventral length 33; dorsal rays 20; anal rays 25; barbel length 200 (72% of length).

Teeth: In each half of the upper jaw are 5 teeth, the second largest, with several small subsidiary teeth. On the maxillary are 4 to 6 denticles, followed by a long line of very minute denticles. The dentition of the lower jaw, except for the absence of denticles, is similar to that of the upper.

Photophores: The photophores of the lateral series are arranged as follows: O-V 48, V-A 22; those of the ventral series: I-P 10, P-V 48, V-A 21, A-O 12.

Barbel: The stem is unbranched except at the very base of the bulb. It is black for a considerable portion of the proximal portion, then this pales and grays, and changes into brilliant lilac with a dark core running through it. The bulb is abruptly bright, clear, picric yellow. The filaments are translucent white with a scattering of black specks.

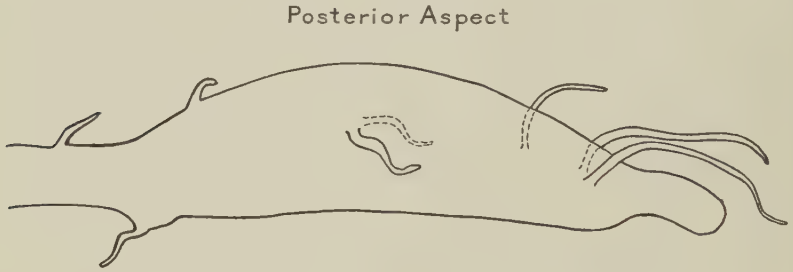

Fig. 10. *Leptostomias bermudensis* sp. nov. Barbel viewed from the left side.

The bulb arises abruptly from the stem, the lilac and the dark center ceasing at once. The bulb is slender, slightly curved, tapers gently from its center, and resembles in shape a diminutive cucumber. It narrows abruptly near the distal end, forming an elongate, rounded, terminal stem.

There are three short, thin median filaments given off, one from the back of the stem, and the other two from the proximal part of the bulb. Half-way down the bulb a pair of larger filaments arises, one from each side. Still farther a single one appears from the right side and, at the point of narrowing into the terminal stem, arises a final pair of filaments, the longest of all, about 4 mm. in length.

Discussion: This species closely resembles *L. macropogon* Norman and *L. longibarba*, Regan and Trewavas, but it may be distinguished from both by the structure of the bulb of the barbel and by the presence of 48 P-V photophores in both the lateral and ventral series.

Photichthys nonsuchae sp. nov.

Type: *No.* 9973, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 63; *May* 3, 1929; *7 miles south-south-west of Nonsuch; 600 fathoms; Standard length* 89 *mm.*

Measurements and Counts: Standard length 89; depth 18 (in length 4.9); head 26.5 (in length 3.3); eye 8 (in head 3.3); interorbital 4.5 (in head 5.9); snout 6.5 (in head 4.1); mandible 18.5 (in head 1.4, in length 4.8); least caudal depth 7.5 (in length 11.9); pectoral 9; ventral 7; dorsal 12; anal 14; gill-rakers 5 + 13 (all, except 4 moderately long ones at the angle of the arch, are very short).

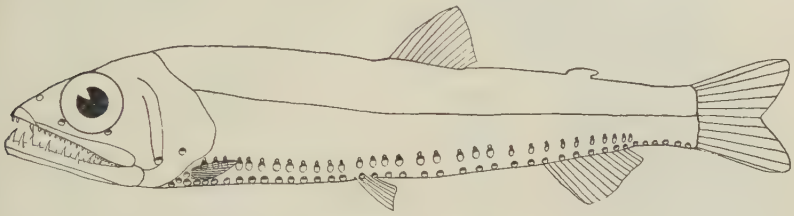

Fig. 11. *Photichthys nonsuchae* sp. nov.

Teeth: There are three pairs of teeth in the premaxillary: two small teeth at each side of the tip followed after an interval by a moderately strong canine. On the maxillary is a single series of about 16 pairs of small teeth with minute denticles between. In the mandible are ten pairs of large teeth with one or more smaller teeth usually present in each of the interspaces. The rudiments of a pair of teeth are barely distinguishable on the vomer. On the palatine are eleven pairs of curved teeth in a single series, decreasing in size posteriorly.

Photophores: There are 14 pairs of branchiostegal photophores. The lateral series of the trunk photophores shows the following arrangement, O-V 12, V- end of series 19. The last lateral photophore is located above the base of the last anal ray. The photophores of the ventral series are distributed as follows: Pre-pectoral 11, P-V 14, V-A 12, A-C 12.

Scales and Skin: All of the scales and most of the skin have been torn away.

Discussion: *P. nonsuchae* agrees with the generic description of *Photichthys* except in the following points: the vomerine teeth are

Fig. 12. *Saccopharynx harrisoni* sp. nov.

extremely rudimentary instead of well-developed and there are but 14 rays in the anal instead of 23 to 26. It differs from *P. argenteus*, the only species previously described, in its greater depth, longer head, larger eye, narrower interorbital width, longer snout, and fewer photophores. Comparative measurements illustrating these differences are as follows:

	P. nonsuchae	*P. argenteus* (according to Günther, Brauer, and Norman)
Depth in length	4.9	5.8 to 6.5
Least caudal depth in length	11.9	16.5 to 21.3
Head in length	3.3	3.8 to 4.8
Eye in head	3.3	4.0 to 5.0
Interorbital in head	5.9	5.0
Snout in head	4.1	5.0 to 5.1
Gill-rakers	5 + 13	5 + 11
Brr. photophores	14	21
Ventral photophores:		
V-A	12	15 to 17
A-C	12	16 to 18
Lateral photophores:		
Entire series	31	33 to 34
Position of last photophore	Above 14th anal ray	Above 6th to 10th anal ray

Saccopharynx harrisoni sp. nov.

Type: *No.* 20,802 *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1010; *June* 11, 1931; *ten miles Southeast of Nonsuch, Bermuda;* 900 *fathoms; total length* 1400 *mm. or* 55 *inches.*

Field Characters: A large-mouthed, extremely elongate, eel-like, black fish; teeth numerous and moderate in size; eyes and pectoral fins present; an elaborate and highly colored, laterally-flattened, luminous organ near the tip of the tail.

Measurements and Counts: Length (total and standard) 1400 mm. (55 inches); head and body 375 mm. (15.7 inches); tail 1025 mm. (39.3 inches); depth, just behind distended stomach 22 mm. (in length 63.6); depth 260 mm. from tail tip, 3 mm.; head to gill openings 113 (in length 12.3); eye 7 (in head 16); snout 12 (in head 9.4); maxillary 85 (in head 1.3); pectoral rays 33; pectoral length 15 mm.

General Description: The general body shape is that of an elongate black sausage, due to a large sized fish which was still undigested in

the stomach; the head, in profile, shows a slight convexity over the crown, and rises slightly to the tip of the snout; this is sharp and the profile of both jaws is a strong curve; the mandible is slender and curves up, shutting closely against the upper jaw. The eye is well-developed and has undoubted vision; the nostrils are large, half-way between the eye and snout, and close together. The anterior is slightly the larger, and each is surrounded by a raised, rounded rim. The gill opening is in the form of a long, narrow slit, 20 mm. in length, beginning at mid-pectoral, between them, and extending far forward.

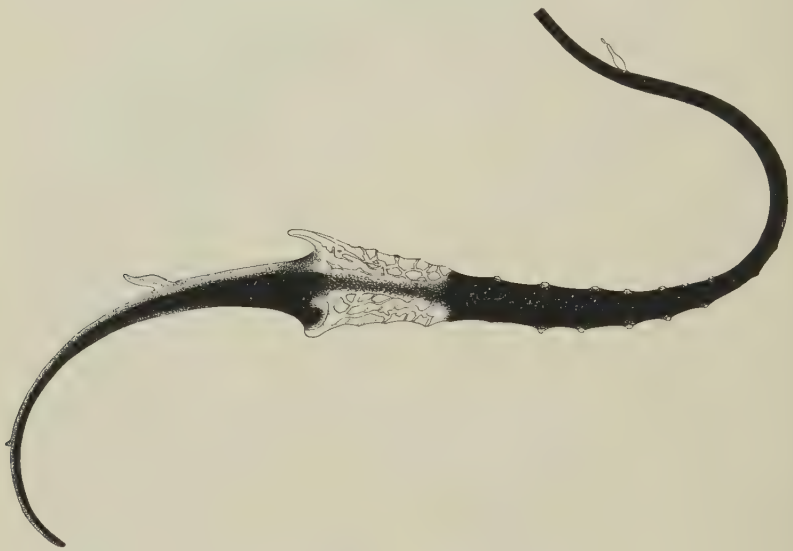

Fig. 13. *Saccopharynx harrisoni* sp. nov. Luminous caudal organ.

Teeth: There are 38 teeth in each half upper jaw, in two irregular rows, those in the outer row much smaller. In each half lower jaw are 30 teeth, in a single row, a large and a small tooth alternating with perfect regularity; the mandibular teeth do not reach very far back and disappear well behind the narrow, upturned symphysis. All the teeth are smooth-edged, but the sides show many irregular striae. The base of each is oval, arising abruptly from a slightly larger, flat, oval sub-base. Some are curved and fang-like, others straight, and they are set rather loosely in the jaws. The largest is 2.5 mm. long.

The skin of the top of the head, the anterior cheeks and around

the maxillary is smooth; all the rest of the skin of head, body, and tail is furrowed with a multitude of longitudinal and criss-cross wrinkles. The fish is jet black except for the specialized, luminous tissue near the tail tip, which is pink, deepening to blood red and dark purple around the base.

The dorsal fin begins far back on the body, just in front of the perpendicular of the anus—the latter opening occurring at about the 12th ray. The anal fin begins 20 mm. behind the anus. The dorsal rays are slightly larger than those of the anal, all are webbed and both fins die out about 200 mm. from the tail tip. The pectorals are paddle-like, with a thick, fleshy, basal pad, and a band of short rays around the free circumference. These are 33 in number and average 3.5 mm. in length. The pad is 10 by 15 mm.

Skin Glands: A few small tentacles are scattered along the lips and on the head,—and on the sides of the tail, from near its base to more than halfway to the tip, similar small tentacles are arranged at equal and frequent distances. At first they are often in pairs but farther along they occur singly, opposite one another, on the midline, about 10 mm. apart. These are not luminescent.

Luminous Structures: On top of the head, 45 mm. back of the snout, a curious structure arises and extends the entire length of the body to within 500 mm. of the tail tip. It consists of two deep troughs, sunk somewhat below the level of the skin and made considerably deeper by rounded, raised rims. Along the back these are very close together, separated by a septum only as wide as the exterior bounding rims. Toward the beginning of the tail these troughs separate and when the dorsal fin begins between them, they are well apart. Half-way down the tail they are 7 mm. apart. Each trough is filled with a bluish white luminous substance. When the fish was taken into the darkroom on its first arrival, a very distinct pale glow was visible along the back, but nothing whatever further back. The dorsal fin rays are each accompanied by a pair of scars or oblique slashes, each of which also contains the whitish substance.

Beginning some distance from the tip of the tail (150 mm.) is a succession of most remarkable structures, positively luminous as I found in the darkroom just before, or at the moment of death of the fish. The first, which is a considerable distance beyond the last finray, is a single pink tentacle, an elongate spindle with a tiny bead at the

tip, arising from the ventral profile. At this point the fish attains its shallowest depth, the tail here being compressed and only 2 mm. deep. For some distance farther the tail is smooth, then, 60 mm. from the tentacle, it begins to broaden and from the dorsal and ventral edges arise thirteen scarlet papillae, on the summit of low mounds almost devoid of black pigment. There are six on the dorsal and seven on the ventral profile. The small mounds are three to four of their base-lengths apart, not symmetrically placed with regard to those of the opposite side.

At an equal distance beyond these begins a most amazing luminous organ, a leaf-like, compressed, almost transparent zone, traversed with a network of large blood vessels. Posteriorly the dorsal and ventral tips are prolonged into exaggerated, finger-like imitations of the preceding papillae. These are scarlet pigmented, not pink with the blood like the rest of the organ. A central longitudinal band of scarlet-dotted, purplish black divides the organ into two. The dorsal finger is much the longer and freer, and there are two more of these dorsal structures trisecting the remainder of the tail. Beyond the leaf organ the tail rapidly diminishes in size, and shows considerable scarlet and purple arranged along both profiles, the scarlet dominant from the last finger-papilla to the tip.

The fish was caught by its teeth in the very collar of the net at the ring, and was saved from swimming away only by being jerked back as the net reached the surface,—a hint probably of how many of the larger fish escape. It was alive and fairly active, opening and closing its jaws, wriggling its body feebly and ejecting a large, half-digested fish. It died just as it reached the laboratory and when we were examining it in the darkroom.

In addition to the faint, colorless glow from the nuchal troughs, we distinctly saw a faint pinkish glow and twice a flash from the specialized caudal organ, and also from several of the scarlet papillae. Under the lens I could later see blood corpuscles moving very slowly along the exposed veins.

Part of the end of the intestine was everted at the anus and I drew out a considerable section together with a second ten-inch digested fish. The stomach had rather thick walls, and numerous longitudinal glandular ridges, the entire mucus lining being wrinkled with very fine, meandering lines and creases.

I have named this fish in honor of Harrison Williams, Esq., through whose continued interest and support these Bermuda Oceanographic Expeditions have been made possible.

Lampanyctus polyphotis sp. nov.

Type: *No.* 10,151, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 124; *May* 25, 1929; 5 *miles south of Nonsuch;* 900 *fathoms; Standard length* 40 *mm.*

Measurements and Counts: Total length 49; standard length 40; depth 8.2 (in length 4.9); head 12.6 (in length 3.2); eye 3.9 (in head 3.2) snout 2.2 (in head 5.7); mandible 8.6 (in head 1.5, in length 4.7);

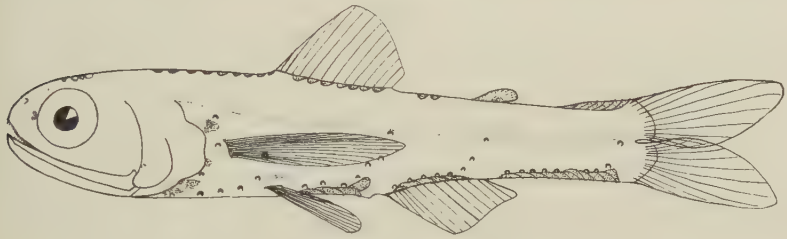

Fig. 14. *Lampanyctus polyphotis* sp. nov.

pectoral 14; ventral 8, origin immediately under that of dorsal; dorsal 13½; anal 14, origin slightly in advance of end of base of dorsal; about 36 scales in the lateral line.

Photophores: PLO slightly below lateral line; 2 PVO in an oblique line, the upper in front of the upper pectoral rays, the lower entirely below the pectoral fin, above the second PO. 5 PO's, the fifth elevated. VLO nearer to base of ventral fin than to lateral line. 5 VO, the first lowered, the fifth elevated. 3 SAO in a broadly angulate series, with the uppermost photophore touching the lateral line and the lower above and slightly behind the fifth VO. AO's 6 + 6. The posterior part of the anal series is entirely behind the base of the anal fin. 2 POL, the upper in contact with the lateral line. 4 PRC, the distance between the first and third about equal to that between the third and fourth. Fourth PRC in contact with lateral line above and slightly behind the third.

Luminous patches and plates: There are 6 small patches arranged

in a circle on the top of the head. In front of the dorsal fin is a single median row of 9 luminous plates, none overlapping. Along the right side of the dorsal are found 8 plates, slightly imbricated, while there are but 7 on the left. About midway between the end of the dorsal and the origin of the adipose are two unpaired plates. There are 7 supra-caudal plates. On the ventral half of the body luminous plates are arranged as follows: There are five plates of various shapes and sizes on each side of the throat, below and in advance of the upper PVO. A similar one is placed above the base of the pectoral fin, while there is a very small patch above the base of the ventral fin. Along the ventral mid-line between the ventrals and the anus are four imbricated plates. Continuous with these is a single pair, consisting of one plate on each side elevated to border the anus. 6 plates, as closely imbricated as those of the caudal series, are found on each side of the anal base. The 12 infra-caudal plates occupy almost the entire space between the end of the anal and the base of the caudal fins.

Discussion: This species seems to be about midway between *Lampanyctus townsendi* (Eigenmann & Eigenmann) of the Atlantic and Indian Oceans and *Lampanyctus maderensis* (Lowe) of the Mediterranean. It may be distinguished immediately from both by the combination of a median series of plates in front of the dorsal fin (characteristic of *L. maderensis*) with a mid-ventral series of plates, exactly similar to those of *L. townsendi,* between the ventrals and the origin of the anal fin.

Lampanyctus septilucis sp. nov.

Type: *No.* 14,292a; *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 250; *July* 4, 1929; *7 miles south-south-west of Nonsuch; 700 fathoms; Standard length* 26.8 *mm.*

Measurements and Counts: Total length 32 mm.; standard length 26.8 mm.; depth 4.7 (in length 5.7 or 17.5%); head 8.0 (in length 3.4 or 30%); eye 1.4 (in head 5.7 or 17.5%, in length 19.2 or 5.2%) snout 1.3 (in head 6.2 or 16.2%, in length 20.6 or 4.8%); maxillary 5.9 (in head 1.4 or 74%, in length 4.5 or 22%); caudal peduncle length 6.0; least caudal peduncle depth 2.4 (in caudal peduncle length 2.5 or 40%, in standard length 11.2 or 9%); distance from snout to dorsal 12.0 (in length 2.2 or 45%); distance from snout to adipose 20.3 (in length

1.3 or 76%); distance from snout to base of ventral 11.2 (in length 2.4 or 42%); distance from snout to anal origin 15.3 (in length 1.8 or 57%); pectoral 15; ventral 8, origin under in front of dorsal; dorsal 12; anal 18½, origin under next to last dorsal ray; about 39 scales in lateral line; 5-13 gill-rakers.

Photophores: 1 minute preorbital photophore between eye and lower part of nostril. 3 or 4 very small post-orbital photophores. 1 shoulder photophore slightly anterior to the most dorsal part of the opercular margin. PLO close to lateral line. Upper PVO opposite upper pectoral rays. Lower PVO somewhat behind upper PVO. 5 PO's, the fourth elevated to the height of the upper pectoral rays.

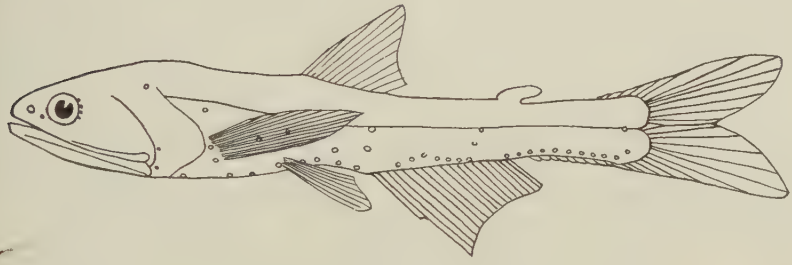

Fig. 15. *Lampanyctus septilucis* sp. nov.

VLO above ventral fin, nearer to lateral line than base of fin. 4 VO's, the second almost imperceptibly elevated. 3 SAO's, strongly angulate, the first slightly in front of the third VO. 7 anterior AO's on the left side, 6 on the right; the second, third, fourth and fifth elevated. 8 posterior AO's on the left side, 9 on the right; the first above the last and second from last anal rays respectively. 2 POL'S, the upper in contact with the lateral line. 4 PRC's, not distinct from posterior AO's; the distance between the third and fourth is about equal to that between the first and third; the fourth is in the lateral line slightly in front of the third. 3 supra-caudal, 9 infra-caudal luminous scales.

Comparison: A second specimen, 14,292b, standard length 27.6 mm., was taken in the same net with the type; and a third, No. 14,061, standard length 29.1 mm., in net 511 on September 27, 1929, thirteen miles south-east of Nonsuch in 700 fathoms. Neither differs perceptibly from the type either in proportions or arrangement of photo-

phores except in the following points: In the second specimen only one small, indistinct, post-orbital photophore is visible instead of the three or four comparatively distinct ones found in the type and in the third specimen. In both the second and third specimens there are seven anterior and eight posterior AO's on each side, instead of the asymmetrical arrangement found in the type. In the third specimen all of the anterior AO's are in a straight line, instead of the second, third, fourth and fifth photophores of the series being elevated.

Discussion: This species is most closely related to *Lampanyctus macropterus* Brauer of the Atlantic, Pacific and Indian Oceans, though it combines certain of the characteristics of *Lampanyctus omostigma* Gilbert 1908 from the tropical Pacific, *Lampanyctus omostigma parvicauda* Parr, 1931 from the western coast of Central America and *Lampanyctus nobilis* Taaning 1928 from the North Atlantic and Pacific. All are set off from the rest of the species of *Lampanyctus* by the combination of long and well-developed pectoral fins, a single luminous organ on each shoulder, but none on the cheeks, the elevated fourth PO, and the confinement of the luminous scales to the caudal peduncle. However, the present species may easily be distinguished from the other four forms by the following points: The VO's are in an almost straight line with the second barely perceptibly if at all raised, instead of having the second noticeably elevated. There are seven anterior AO's (except on the right side of the type specimen), instead of from four to six. The fourth PRC is located in the lateral line slightly in advance of the third, instead of behind it. Finally, the new species has fifteen pectoral rays instead of thirteen.

The following table is a comparison of the fins, number of scales in the lateral line, and the photophores of the new species with those of *Lampanyctus macropterus* and *Lampanyctus omostigma omostigma:*

	L. septilucis (*type*)	*L. macropterus* of Brauer and Parr	*L. omostigma*
Dorsal	12	12 to 14	14
Anal	18½	18 to 19	18
Origin of anal	Under next to last dorsal ray	Under middle of dorsal	Under next to last dorsal ray
Pectoral	15	13	13
Ventral	8	8	9
Lateral line scales	about 39	35	39

Photophores			
Postorbital	3 or 4, very small	None mentioned.	None mentioned.
Preorbital	As in *L. macropterus* and *L. omostigma*	1 minute photophore between eye and lower part of nostril.	
Shoulder	As in *L. macropterus* and *L. omostigma.*	1 between upper part of praeoperculum and operculum.	
PLO	As in *L. macropterus.*	Close to lat. line.	2/3 as far from lat. line as from pectoral base.
PVO-upper	As in *L. omostigma.*	Opposite middle pectoral rays.	Opposite upper pectoral rays.
PVO-lower	As in *L. macropterus.*	Somewhat behind upper PVO.	Almost directly beneath upper PVO.
PO's	As in *L. macropterus.*	5. 4th elevated to height of upper pectoral rays.	5. 4th elevated to height of lower middle pectoral rays.
VLO	As in *L. macropterus* and *L. omostigma.*	Above ventral fin, nearer of fin.	to lateral line than base
VO's	4. 2nd scarcely elevated.	4. 2nd well elevated.	4. 2nd well elevated and above or slightly in advance of 1st. 3rd also elevated.
SAO's	As in *L. macropterus* (1st SAO in front of 3rd VO as in Brauer)	3. Strongly angulate. 1st slightly before or behind 3rd VO.	3. Not so sharply angulate. 1st behind 3rd VO.
AO's-anterior	7 on left side, 6 on right. 2nd, 3rd, 4th and 5th slightly elevated.	4 to 6. 2nd, 3rd, and 4th elevated.	5. 2nd, 3rd, and 4th elevated.
AO's-posterior	8 on left side, 9 on right. 1st above last and 2nd from last anal ray respectively.	8 to 10. First above next to last or 2nd from last anal ray.	8 or 9. First above 2nd from last anal ray.
POL's	As in *L. macropterus* and *L. omostigma* (except that upper organ barely touches lateral line).	2. Upper in contact with lateral line, (Gilbert counts lower POL as the 6th anterior AO).	
PRC's	4. Continuous with posterior AO's. 4th in lateral line slightly in advance of 3rd.	4. Distinct from posterior AO's. 4th in contact with lateral line, slightly behind 3rd.	4. Continuous with posterior AO's. Arranged as in *L. macropterus.*
Luminous Scales			
Supra-caudal	3	3 to 4	4
Infra-caudal	9	5 to 10	9

Omosudis lowi
(Post-larva)

Post-larva Number 22,904, *Bermuda Oceanographic Expedition, New York Zoological Society; KOH Cleared Collection No.* 998; *Net* 1245: *August* 31, 1931; *eight miles south-east of Nonsuch;* 1000 *fathoms; standard length* 10 *mm.*

Measurements and Counts: Total length 11.45 mm; standard length 10 mm; depth 2.1 (in length 4.8); head 3.5 (in length 2.88); eye .86 (in head 4); snout 1.3 (in head 2.7); maxillary 2.4 (in head 1.45); pectoral rays .86; pectoral fleshy base .6; anal fin 14 rays; caudal 10 + 9; longest fang .54 mm.

General Description: This young post-larva is white throughout, with a sparse scattering of black dots; a few along the operculars and on top of the brain, and about a dozen down each side of the back, a third the length of the body; a squarish dark saddle on the back in the

center of the highest part of the dorsal fin-fold and just in front of the vertical of the front of the anal; six black dots along the ventral outline in front of the anal. All the fins are hyaline, except the pectoral which is quite dusky. The iris is solid silver, the spicules vertical.

The round protuberant stomach is dusky with thickly clustered,

Fig. 16. *Omosudis lowi.* Post-larva of 6.58 mm.

very large dendritic chromatophores, while on top they form a solid black patch. This stomach contained a white, post-larval Myctophid of the same length (10.2 mm) as the *Omosudis.*

Dyed and Cleared: The osteological development at this stage is very interesting. There is not a particle of bone in the entire body,

Fig. 17. *Omosudis lowi.* Post-larva of 10 mm.

fins, fin rays or appendicular skeleton, except for a faint trace in the center of the supracleithrum.

The head is set sharply off as a series of elongate, bracing bones, strongly ossified, and forming a nearly perfect equilateral triangle, the corners being the posterior borders of the frontals, the snout and the quadrate.

The entire top of the head is covered with the thin but well-ossified frontals, broad and rounded behind, and narrowing as they extend forward, until their needle tips actually touch the lateral, flaring, wing-like, superior edge of the still unjoined premaxillaries; a strongly ossified, buttressed ridge begins at the postero-lateral rim of the frontals where it shows two branches at right angles, and extends down the entire length of these bones. Its upper edge is looped from one body brace to another as far as mid-eye, and crenulated after that. The parietals show only as small oval, faintly pink cartilage; the sphenotics are better ossified and show a low, sharp spine; only the basal condyle of the opercular is ossified, the remainder being clearly outlined in cartilage; the hyomandibular is ossified only on the anterior edges; the preopercle is strongly ossified, beginning as a needlepoint in front of the opercular condyle and extending clear to the quadrate, slightly bowed, flaring in the posterior lower half into a broad, looped, bony web between strong spines.

The premaxillaries are not united at the symphysis; they extend back as the slenderest needles of bone, three-fourths of the way to the quadrate, with teeth all the way; there are fifteen altogether, the 1st, 3rd, 5th and 7th larger than the rest, the 5th a depressible fang of large size; the edentulous maxillary is a veritable thread of bone, well ossified, and flattening out toward its distal end; the palatine is stronger even than the premaxillary, arising at the vertical of the 5th tooth on the premaxillary, and extending back to beyond the vertical of the mid-eye; it bears five teeth longer than most of those in the upper jaw; posteriorly the palatine is overlapped by the slender spindle of the mesopterygoid, and this by the larger pterygoid.

The dentary is as strongly ossified as the premaxillary, and its two posterior forks reach almost to the quadrate; in the extreme front are two moderate-sized teeth, followed after a space by very tiny teeth; halfway down the jaw is a single enormous fang, with an auxiliary tooth of equal size just behind but lying flat, and ossified at the tip; halfway between this and the posterior tip of the upper prong is a single very small tooth, making five in all; the articular is thoroughly ossified only along the lower margin, and merges very closely with the angular; the quadrate, like the opercular, is surprisingly cartilaginous, and only its

condyle and the adjoining area are ossified. The basisphenoid is a strong rod and completes the tale of visible bones in this post-larva.

Post-larva Number 23,073, *Bermuda Oceanographic Expedition New York Zoological Society; Net* 1258; *September* 3, 1931; *eight miles south-east of Nonsuch;* 900 *fathoms; standard length* 6.58 *mm.*

Ossification much the same as in the 10 millimeter specimen, with a diminution in the development of the head bones such as might be expected in a fish one-third less in length. This individual had swallowed a squid quite as large and slightly longer than itself.

Melanonus unipennis sp. nov.

Type: *No.* 22,397, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1182; *August* 15, 1931; *ten miles south-east of Nonsuch;* 700 *fathoms; standard length* 62.5 *mm.*

Measurements and Counts: Total length 70 mm.; standard length 62.5 mm.; depth 10 (in length 6.25); head 13.5 (in length 4.6) eye 2.8 (in head 4.8); snout 5.2 (in head 2.6); maxillary 8.2 (in head 1.6); interorbital 5.5 (in head 2.46); pectoral 16; pectoral length 8; ventral 7; ventral length 6.4; dorsal 100 (72 + 28); anal 79 (56 + 23); caudal 6; caudal length 7.5; scales 112; branchiostegals 7. Teeth in upper jaw, very numerous, small and in several rows, a few slightly enlarged canines in front; mandibular teeth fewer and larger, in two irregular rows, the inner row much larger than the outer.

Comparison: All the fifty-odd specimens of *Melanonus* which have been taken at our station show a united dorsal fin. There is no sign of division into two, between the first six to eight and all the remaining rays. Comparison must be made with *M. zugmayeri* of Norman as he distinguishes it from the type and other specimens of *M. gracilis* as the only one occurring in the North Atlantic.

The depth of my specimen is much less than that of *zugmayeri* (6.25, not 4.9); the head is smaller (4.6, not 4); the snout is longer (2.6, not 3.5); the dorsal fin is slightly larger (72, not 70) and the anal still more so (56, not 50); the posterior rays of the so-called third dorsal, second anal and caudal are more numerous in my specimen (57, not 50); the pectoral has more rays (16, not 13); and the lateral row of scales is fifteen percent greater in *unipennis* (112, not 80).

Pseudoscopelus stellatus sp. nov.

Type: *No.* 21,155, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1058; *July* 7, 1931; *eight miles southeast of Nonsuch; 300 fathoms; standard length* 23 *mm.*

Field Characters: A small elongate dark-skinned fish, with scattered iridescence, especially strong on the opercles, and a circle of successive rings of brilliant colors on the side, behind the pectoral fin. Double dorsal and elongate anal. Lines of small green chromatophores along the ventral surface from the isthmus to the caudal, small clusters on the mid-mandible, on the lower part of the preopercle, and at the base of the pectoral.

Measurements and Counts: Total length 26.5 mm; standard length 23; depth 4.5 (5.1); head 7.1 (3.2); eye 1.8 (3.9); snout 1.7 (4.2); maxillary 4 (1.8); interorbital 1.8 (3.9); dorsal VII-26; anal 26; pectoral 14; pectoral length 8; ventral 5; ventral length 4.3 mm.

General Color: Purplish brown, with tinge of pink on head and base of caudal; black chromatophores thickly scattered over most of the fish, while on the head and at base of caudal these are mixed with numerous flame-scarlet dots, most conspicuous on upper and lower jaws and in the anterior part of the isthmus. Mouth pale, speckled with black and scarlet inside. Proximal half of dorsal, anal and caudal rays speckled with black, pectorals and ventrals at their bases only.

Iris: Steel blue with greenish reflections and a scattering of black chromatophores around the edge.

Iridescence: Covering much of the fish, but especially strong on the sides of the head and anterior sides; consists of fine spicules on the dermis, in some places well separated from the transparent epidermis which carries the dark chromatophores; peacock blue just behind opercles and in front of ventrals; green in front of pectorals. Behind pectorals, partly beneath the fin-rays and partly above them, a peculiar iridescent area, the general impression being of a large, oval, green, bronze and blue ocellus as large as the eye: center blackish, around which is a ring of gold, then bronzy green, then blue and finally an outer ring of bluish violet. This last color extends forward to the opercle, and backward in a gradually diminishing band between the lateral line and the ventrals as far as the anal fin. Ventrally, along the abdomen, this changes to a greenish-black sheen visible only in some

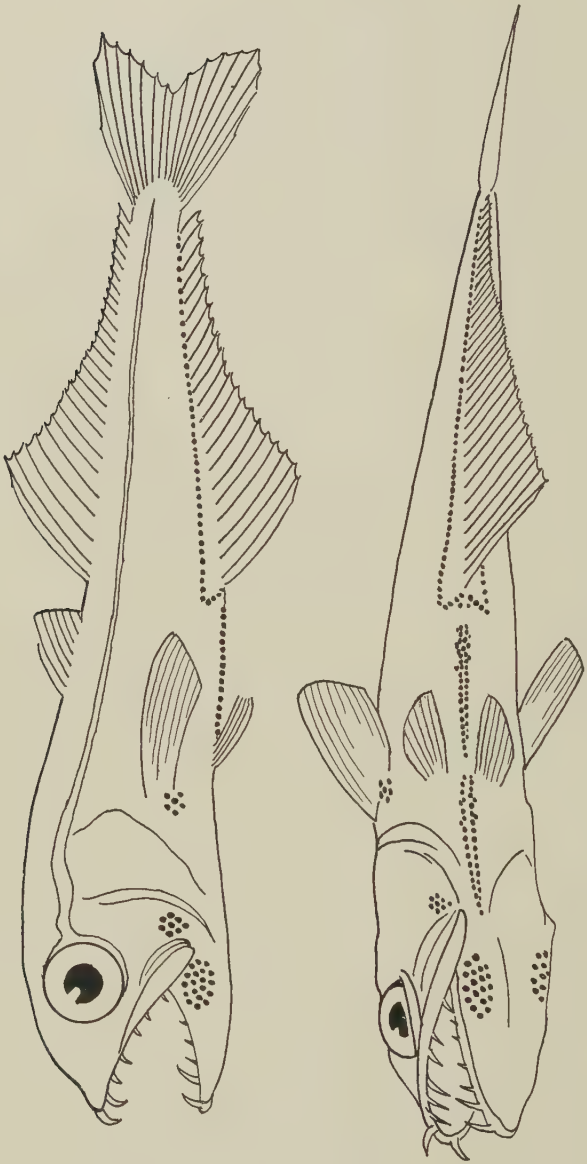

Fig. 18. *Pseudoscopelus stellatus* sp. nov.

lights. Preopercle is shining blue, opercle golden-green. The gills show through the branchiostegal membrane as bright pink.

The lateral line is a deep groove, bordered by a connected series of overlapping fleshy flaps. In life these meet across the lateral line, so that only occasional, separate openings are visible. When relaxed in death the two series of leaves or scallops spread apart and the trough is open throughout. In the fresh specimen a faint bluish iridescence is visible along the lateral line.

After death both body and fins become covered with a complete coat of thick mucus, which is replaced at least twice after being cleaned off.

Photophores: In the fresh fish the numerous photophores (354 altogether) are clear bright green—Night green of Ridgway. The organs are facetted as in those of *Cyclothone,* but from every angle show the same green, clear and intense. Within fifteen minutes after death the lights begin to fade to silvery white, those of the preopercle and mandible long before the ventral body lights.

Photophore Counts: Mandibular—19 in a compact, oval group on each side, beneath and in front of the posterior end of the maxillary.

Preopercular—8, in a small group at the lower tip of the triangle of this bone.

Base of Pectoral Fin—5 and 6, on the two sides respectively. Ventral Midline, Isthmus to Ventrals,—54, mostly in a double row, placed very close together, but with several irregularities.

Ventrals to Anus—47, beginning somewhat behind the ventral fins and ending well in front of the anus; usually in a double row, but irregularly single or triple especially in the extreme anterior and posterior portions.

Circum-anal—Right 89, left 90. This line completely surrounds the anal fin except for a slight break around the posterior end. The line is single except between the anus and the anterior beginning of the fin where it is irregularly double. These photophores are not equally spaced, nor are they all equal in size, and the slight gaps and congested areas do not correspond on right and left sides.

Pre-caudal—9, which are slightly larger than the circum-anal lights and are arranged in an unsymmetrical, roughly Y-shaped group, on the midventral line, just in front of the origin of the caudal fin.

Discussion: *Pseudoscopelus scriptus* was described in 1892 by Lütken (Spolia Atlantica (2) 1892, pp. 284-285) and since then redescribed and pictured by Goode and Bean (Oceanic Ichthyology, 1895, pp. 292-293, figure 266) and Norman (Annals and Magazine of Natural History, 1929, (10) Vol. III, pp. 543-544, figure 11).

Owing to the small size of the photophores and their ultimate superficial obscurance by mucus, all these authors have described them as mucus pores. Norman even omits them from his illustration. Goode and Bean depict them correctly but describe them as "series of closely placed pores" while Norman says in his caption "The rows of small pores on the head and body have been omitted."

Pseudoscopelus stellatus differs from Goode and Bean's description of *Pseudoscopelus scriptus* in various proportions; in having no cross-line of "pores," placed "immediately behind the ventral fins"; and the length of the pectoral fins is not "nearly three times as great" as the ventrals, but less than twice. The illustration shows a line of "pores" along the maxillary and two shorter lines along the mandible, while in *Pseudoscopelus stellatus* these are absent, there being two groups, one on the preopercle, and the other on the mandible. The group of photophores at the base of the pectoral in *Pseudoscopelus stellatus* is wholly lacking in Goode and Bean's illustration.

Norman states "diameter of eye 6, interorbital width nearly 3 in head," while the corresponding proportions in my fish are 3.9 in both cases.

The short rounded snout, the several rows of palatine teeth and the presence of "definite rows of small mucous pores" (= photophores) clearly sets this fish off from *Chiasmodon* and places it in *Pseudoscopelus,* but it very distinctly has the several pairs of anterior, large, recurved, canine fangs supposedly characteristic of the former genus.

Several young *Pseudoscopelus stellatus* have come up in shallow hauls.

No. 21,404, (2), Net 1084, July 15, 1931, are from a depth of twenty-five fathoms. This number includes two fish of 20 and 23 mm. respectively. Although the latter is quite as large as the type yet it is distinctly a larva. In general color both are pale pink with numerous black dots, strongest dorsally. There are strawberry-pink patches in the following positions, similar in both individuals: one at the base of the 1st dorsal, four along the 2nd dorsal, three along the anal, and five

on the midline of the body, distributed evenly from the vertical of the 1st dorsal origin to the base of the caudal. These bright pink spots are thickly peppered with small black chromatophores. The caudal is densely speckled with black.

The iris is silver, edged with black. The opercle shows a strong steel blue, golden and green iridescence. On the sides, and extending down almost to the abdomen is a conspicuous rainbow series of colors, adumbrating the ocellus of the adult. Here, however, it is an elongated, semi-ellipse instead of an oval, and extends from the top of the pectoral base almost to the anal fin. Deep violet ventrally, it ranges through bluish-violet and peacock blue to emerald green and gold.

In both these individuals there is a distinct trace of the ventral photophores, about four pairs between the ventrals and anal, and an equal number at mid-anal. There is also a hint of the cluster of photophores on the mid-mandible. These beginnings are in the form of distinct black centers to very large, dendritic chromatophores. There are also unusually large chromatophores between the anal and caudal, anticipating the irregular peduncular line of light organs. There are two rows of teeth on the palatines, and at the premaxillary symphysis are two pairs of large, sharply bent, backward pointing fangs.

A still younger individual of this species is No. 21,321 of Net No. 1069, hauled on July 10, 1931 from a depth of 50 fathoms. It is 14 mm. standard length, and in general color is white, with oblong, longitudinal patches of grenadine-red chromatophores placed as follows: three along the anal base, one under the anterior dorsal fin, three under the 2nd dorsal, and four along the mid-line between the base of the dorsal and the base of the caudal. The two posterior colored areas of both dorsal and anal fins are each overlaid with two, large, black pigment spots. There is a slight duskiness on the top of head and tip of snout. The fin-rays are white with an irregular sprinkling of black and reddish chromatophores.

The smallest *Pseudoscopelus stellatus* measures 10 mm. in standard length. It is No. 21,456, Net No. 1093, taken July 18, 1931, from 300 fathoms depth. It is translucent white with red spots, one at midbody on the midline and one each at the center of the 2nd dorsal and of the anal. The crown of the head has a group of small, round, black chromatophores. Iris silver, laid thinly over the black of the eyeball.

Fig. 19. *Parabrotula dentiens* sp. nov. Jaws.

The following table shows the relative changes in growth in three specimens:

$\frac{\text{Standard}}{\text{Length}}$	$\frac{\text{Head}}{\text{Length}}$	$\frac{\text{Eye}}{\text{Head}}$	$\frac{\text{Snout}}{\text{Head}}$
10	3.7	3	2.7
20	3.3	4	3.5
23 (Type)	3.2	4	4.2

Parabrotula dentiens sp. nov.

Type: *No.* 15,882, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 692; *June* 12, 1930; *eight miles southeast of Nonsuch Island, Bermuda; 800 fathoms; standard length* 28 *mm.*

Fig. 20. *Parabrotula dentiens* sp. nov.

Field Characters: A small, black, scaleless, brotulid fish, with large oval eyes, projecting lower jaw, no ventrals, vertical fins beginning at mid-body and continuous with the longer rayed caudal.

Measurements and Counts: Standard length 28 mm.; total length 28.9 mm.; depth 2.7 (in length 10.3); head 4.8 (in length 5.8); eye .86 (in head 5.5); snout 1.5 (in head 3.2); maxillary 2.7 (in head 1.8); mouth angle 20° up; ocular angle 20° up; ocular divergence 25° forward; branchiostegals 6; vertebrae 59 (23 + 36); pectoral 7; pectoral length 1.2 (in head 4); dorsal 41; anal 39; caudal 6; caudal length .9 mm.

General Description: The color is jet black; the body is elongate, the head flattened above, sloping straight down from nape to snout; the eye is large, oblique, oval, covered by thin transparent skin; the gape reaches behind the eye, the lower jaw projecting in front.

The teeth are wholly lacking in the upper jaw, but there are twelve in the lower, small, far apart and bent sharply backward. The skin is thin and scaleless. The vertical fins are composed of soft cartilaginous jointed rays; the pectoral rays are soft and cartilaginous except at the base; the ventrals and the pelvic arch are wholly lacking.

Osteology, from the stained and cleared type: There are 59 vertebrae, 36 of which may be termed caudal. All are well ossified except the two posterior ones, which are cartilaginous, showing faintly, together with a solid caudal basal support, and a hint of urostyle. There is no apparent division between trunk and tail vertebrae except the position of the anus. The neural and haemal arches are well developed, long, and slant slightly backward, but there are no other appendages.

The basis cranii is the only part of the skull to show very evident ossification. The cleithrum and supracleithum are strongly ossified, as are the opercle and interopercle. The other elements are barely visible. The 1st branchiostegal has no visibly ossified point of attachment. From a very faint ceratohyal arise the 2nd and 5th backward curving branchiostegals and a 6th extends almost straight between the two better developed opercular bones. The quadrate is strong.

The premaxilla and maxilla are slender, almost rodlike, the latter ending far from the quadrate, and both are toothless. When any opening pressure is applied to the jaw, it is the upper which opens, the snout wrinkling above, giving along the posterior cartilage. The mandible is remarkably strong, both dentary and angular, and shows but slight downward movement. There are six, very small, widely separated, backwardly directed teeth on each ramus of the former, the first well away from the symphysis. Of the pectoral fin, only the bases and a fraction of the seven rays show any ossification. The dorsal, anal and caudal rays are soft and wholly lacking in bony tissue.

The oesophagus is large and distended, and there is little differentiation into stomach and intestine in the undissected fish.

Much of the body is filled with masses of small oil globules, especially behind the eye, and again behind the aural cavity, over the surface of the body organs, and a solid mass down the bases of the vertical fins, along the entire profile of the body.

Comparison of No. 15,882 with *Parabrotula plagiophthalmus*:

The appended table shows at a glance the difference between my specimen (No. 15,882) and the one described by Zugmayer.* The major distinctions are that my fish, while about the same length, has a much longer anal fin, a shorter pectoral, the body is more slender, the head and eye are smaller, the mouth larger, and there are teeth present.

*Zugmayer, Bull. Oceanogr. No. 193. Monaco, 1911; Zugmayer, Res. Camp. Scient. Albert First; Fas. XXXV, 1911, p. 129, Plate VI, fig. 5.

Monaco's fish was taken at 1500 meters depth, 43° 4′ No. Lat., 19° 42′ West Longitude, about 480 miles north-east of the Azores.

	Parabrotula plagiophthalmus	*P. dentiens* No. 15,882
Standard length	24 mm.	28
Dorsal	40	41
Anal	30	39
Pectoral	7	7
P. length	2.3 mm.	4 mm.
Caudal	5	6
Depth in length	8	10.3
Head in length	4.5	5.8
Mouth in head	2.3	1.8
Maxillary	mid-eye	behind eye
Eye in head	4.3	5.5
Branchiostegals	5	6
Teeth	0	12 in mandible

Chaenophryne crossotus sp. nov.

Type: *Number* 20,809, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1015; *June* 15, 1931; *eight miles south-east of Nonsuch;* 500 *fathoms; standard length* 17 *mm.*

Measurements and Counts: Total length 20.7 mm.; standard length 17 mm.; depth 9.4 (in length 1.8); head 11.4 (in length 1.5); eye 1.5 (in head 7.6); snout 6.8 (in head 1.67); mandible 8.5 (in body 2); pectoral length 2.3; dorsal 7; anal 6; caudal length 3.7; illicium 5.7 (in head 3).

General Description: Outline typically chaenophrynine, strongly arched above, almost flat below, snout short and blunt, peduncle narrow and tapering into caudal; eye small, directed considerably forward; nostril openings at end of small tube near tip of snout; mouth large, almost horizontal, gape well behind eye: Teeth very small and few in number in upper jaw, about five on each ramus; ten on each half mandible, about half of them twice as large as the others, and three times as long as those in the maxillary; three pairs of vomerine teeth; the skin is velvety jet black as are all the fins; the anterior half of the lower lip is pale, fitting into the loose upper lip when the mouth is closed; no spines are visible; the rays of all the fins are encased in black skin, with the brushy tips white.

The illicium base bone is wholly concealed under the skin; the stem emerges close to the tip of the snout, black for half its length, and

becoming pale translucent white where it rises above the deep trough; it widens anteriorly into the large bulb, the posterior profile remaining straight; a brown inner core occupies about a third of the posterior aspect of the translucent stem, and flares quickly into the oval, blue-black bulb; at the upper end of the bulb there arises a pair of black spheres balanced side by side on the end of short stalks; immediately behind them is a small saddle-shaped black mark; at the postero-

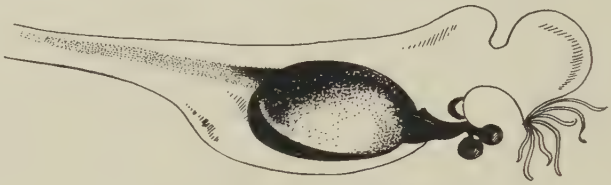

Fig. 21. *Chaenophryne crossotus* sp. nov.

superior edge of the illicium a broad high translucent, white crest arises, divided mid-way by a deep posterior notch and flaring out distally into a round comb, with an anterior point from which springs a tuft of seven, slender, thread-like white tentacles.

Chaenophryne draco sp. nov.

Type: 22,396, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1181, *August* 15, 1931; *ten miles south-east of Nonsuch; 600 fathoms; standard length* 18 *mm.*

Measurements and Counts: Total length 23 mm.; standard length 18 mm.; width 10 (in length 1.8); depth 9.7 (in length 1.85); head 12 (in length 1.5); eye .8 (in head 15); snout 4.5 (in head 2.6); maxillary 4.3 (in head 2.8); visible dorsal rays 4; visible anal rays 2; pectoral 18; pectoral length 2.1; caudal 9; caudal length 5; illicium length 6.4.

General Description: Snout rising from upper jaw almost vertically, then continuing into the long, even dorsal curve which straightens out gradually to the tail; the ventral outline is almost horizontal; eye rather small, just back of the gape, half-way between the gape and the dorsal outline; nostril on a low tubercle, close to tip of snout; mouth large, horizontal.

Teeth very small and few in number in the upper jaw, six in each

ramus; those of the lower jaw are two to three times as long, and nine to ten in each half jaw, four of these being long curved fangs; there are three pairs of vomerine teeth, strongly graduated, the smallest in front.

The skin is jet black, with a surface which looks like the nap of black velvet, except the lips which are smooth and dark brown; the fins are all black, only the illicium is different in color. There are no surface glands visible and spines are wholly lacking, although the infra-

Fig. 22. *Chaenophryne draco* sp. nov. Illicium at right.

posterior mandible angle is clearly indicated through the skin. The rays of the ventral fins are low and inconspicuous and probably not all project through the outer skin; each is enclosed in a black sheath, but bare at the tip, like the rays of the pectoral and caudal.

The illicium is a very complex organ, but lacks elaborate tubercles. The basal bone arises half way between the vertical of the eyes and the snout, but is visible only from above and that for but a short portion of its length; posteriorly it disappears at once beneath the skin, although the outer skin itself is devoid of pigment for a short distance farther; it then sinks below the surface, leaving a deep, narrow, epidermal furrow which persists on the top of the skull, to a point well behind the eyes. From above, the anterior profile of the elbow of the basal bone and the illicium stem just reaches the vertical of the tip of the snout;

the stem is translucent, pale purplish blue, the terminal bulb convex anteriorly, the stem continuing straight up behind; at the anterior base of the bulb is a large, round pad of pinkish-white, silvery spicules, sending a long, narrow extension upward; beneath this is an ebony plaque, on each side of which the silvery spicules extend up from below, ending in an irregular edge on the black. Distally, where the line of spicules dies out, a new and complex structure begins; on mid-body is a rounded, black flap like the full-spread tail of a bird lined along the edge with silver, while from each side sprout two moderately elongate black wings, thickly mottled with brown; beyond there is a thick, tubular body, extending to the anterior tip of the illicium, black, graying gradually to white at the end; on each side near the base of this tube in advance of the wings and projecting back beneath them, are two smaller tubes of pale bluish, each ending in a plug of silvery spicules; beneath the median terminal, tubular body and separate from it, is a fin-like extension of the translucent, bluish-purple tissue, transverse like the fin of a squid.

Dolopichthys gladisfenae sp. nov.

Type: *No.* 15,490, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 639; *May* 28, 1930; *six miles south of Nonsuch Island, Bermuda; 700 fathoms; standard length* 40 *mm.*

Field Characters: A somewhat elongated Dolopichthid, articular spines absent, skin spiny, teeth few, dorsal 5, anal 5, illicium 4.7 in length, bulb structure complicated.

Measurements and Counts: Standard length 40 mm; total length 54 mm.; depth 16 (in length 2.5); head, to gill openings 20.7 (in length 1.9); eye 1.1 (in maxillary 4.5); snout 3.3 (in maxillary 1.5); maxillary 5 (in length 8); intersphenotic 7.1; mouth angle 30° up; ocular angle 15° up; ocular divergence 10° forward; pectoral length 3.8; dorsal 5; anal 5; caudal 9 (2+4+3); caudal length 14; illicium 8.5 (in length 4.7); basal bone 3.1 mm.

General Description: The fish is elongate and moderately deep; the back is parallel with the ventral outline, almost horizontal; the anterior profile shows a slight downward curve from sphenotic to snout; the head is elongate, somewhat flattened above and below; the interorbital to the snout is free of spines, longitudinally elevated, with a

deep groove down the center; the snout is round in profile, flattened above; the eye is small, the nostril is a thick, short tubercle, placed two-thirds of the distance from eye to illicium; the mouth is moderately large, terminal and oblique; the maxillary reaches the front of the eye.

The teeth consist of nine small, sharp, subequal pairs in the upper jaw, set in a deep, wide groove formed by the rounded lips on one side, and an inwardly stretched, dark, dermal velum within; there are twelve pairs of larger teeth, graduated in threes, in the lower jaw; three vomerine teeth are visible on each side, strongly graduated, the shortest toward the mid-line.

The skin is smooth on the illicium, lips and a wide area from behind the sphenotic spines forward to the mouth; everywhere else it is beset thickly with small spines, and a scattering of mucus glands in the form of short, stout tubercles (as in *Cryptosparas*); the articular spines are absent; the sphenotics are small and sharp, projecting less than 2 mm. above the surrounding surface, about half of the height free of skin; the dorsal and anal fins have low, separate rays, very broad at the base, tapering to an exposed, fine point, useless for swimming; the pectorals are short, thickset, of thirteen rays.

Illicium: The illicium arises from near the tip of the snout, directed low and obliquely forward. It is jet black to the first joint, the pigment then thinning out, only along the sides reaching the base of the bulb as a faint duskiness. Above and below, the stem becomes abruptly milky white. The core is dark and upon its tip is placed the bulb, rounded except on the bottom which is flattened and curved inward to the core. The bulb is jet black with the basal half covered with iridescent, glittering spicule scales, silver, green and bronze, arranged with their long axes concentrically. The top of the bulb is of pale, lemon yellow, luminescent material, with the center changing abruptly to bright yellow, and from each side of the base of this a triangle of the glittering scales extends down over the black area. Above the cap and close to it, there arise from the center three flat, horizontal, fan-shaped disks of the luminous yellow. All the structures thus far mentioned are included in the coating of translucent, milky tissue.

Viewed from above, the bulb shows its lower half and a thin line around the cap covered with the glittering scales, elsewhere jet black. In the center, the black of the bulb rises a little, and is capped by a tiny mound of the bright scales. Above this the protecting tissue

(which shows transparent in a downward view over the bulb) is drawn up into a point, tipped with three finger-like tubercles, turning white at the tips. Beneath there is a misty, pale green tissue, very delicate, looking like a puff of pale green smoke. The lemon cap is split down the center fore and aft, and the green mist disappears into the anterior part of this crevice, where it becomes a deeper emerald green. Suspended above this is an intricate, silvery scaled structure like a bird in flight—the head of the bird with three black dots, close behind the base of the green smoke, the silvery wings stretched wide on each side. The body above and behind is encased by the mass of tentacular matter—the large rounded, elongated, thick projection, with a similar, smaller one directly behind, both composed of delicate, cobwebby, frosted tissue. Halfway down the larger, many small isolated, pale pink tentacles appear (28 are visible at once from one angle), and these increase in number, complexity and length, and become deep pink, until the two terminal projections, the body and half the wings of the silver bird, are buried in a mist of pink. Posterially, behind and below the second protuberance, two long finger-like tentacles arise, widely separated from the grey covering tissue.

Dolopichthys tentaculatus sp. nov.

Type: *No.* 23,170, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1271; *September 7th,* 1931; *ten miles south-east of Nonsuch;* 600 *fathoms; standard length* 13.5 *mm.*

Measurements and Counts: Total length 19.5 mm.; standard length 13.5 mm.; depth 7 (in length 1.9); head 9.3 (in length 1.4); eye .86 (in head 18); snout 2.1 (in head 4.4); mandible 5.7 (in head 1.6); pectoral rays 18; pectoral length 2.4; dorsal 4; anal 4; caudal rays 9; caudal length 6; illicium basal bone 1.8; stem and bulb 2.8; dorsal illicium tentacle 4 mm.

Description: Body typically dolopichthine in shape, enormous, high-arched head and back, horizontal ventral surface; pectoral and caudal fins well-developed and functional; vertical fins with barely projecting tips, wholly useless; sphenotic and articular spines prominent; quadrate and mandibular spines small, the former slightly the larger. Basal bone of illicium arising halfway between eyes and tip of snout, extending well in front of snout and jaw.

Fig. 23. *Dolopichthys tentaculatus* sp. nov.

Body, all fins, basal bone and proximal half of illicium stem dark seal brown; iris dark blue with a scattering of silver spicules; teeth transparent, colorless. The brown of the illicium stem includes about one-third of the bulb, the distal two-thirds being blue-black. From the dorsal side of the bulb (in its usual forward pointing position) arises, at right angles, a long, slender, pliable, colorless, translucent tentacle, tapering only slightly; from the opposite, ventral side of the bulb springs a rather stout, even-sided projection, pale brown except at the tip where it shows two, lateral, luminous facets. The whole structure is included in the translucent tissue, very thin along the brown part, but extending beyond the tip in two protuberances, one above the other, the upper a short, colorless tubercle, the lower a longer, upturned curved tentacle. From the upper part near the extremity of the brown tube arise two small, luminescent tubercles. There is a second pair of luminous facets on the bulb near the base of the tube.

Between the elongate dorsal tentacle and the ventral tube the blue-black of the bulb is split vertically, showing silvery tissue, and giving rise to several specialized organs. Near the base of the long tentacle there is a widening of the sub-silver, and this same tissue is raised above the level of the bulb into a thick, flat-topped comb, the summit of which is black; at the anterior base of this comb two large flat, triangular leaves of black tissue arise, and extend out, over and

above the surface of the bulb. Halfway between their bases and the tube-like, ventral luminous organ three, slender-stemmed, translucent, twisted leaves spring from a single base.

Mandibular teeth are very long and slender, the tips slightly incurved; there are thirteen in each half-jaw, graded in size by two's and three's; the teeth of the upper jaw are small and fewer in number, nine or ten on each side. Three good-sized teeth on vomer.

Comparison: This is closest to *Dolopichthys obtusus* the type of which is excellent for comparison for it is of exactly the same size. Among other dissimilarities each species has a different arrangement of structures on the illicium bulb and, curiously, the arrangement is reversed.

Linophryne arborifer Regan
(Post-larva)

Specimen No. 22,400, *Bermuda Oceanographic Expedition, New York Zoological Society; Net Number* 1182; *August* 15, 1931; *ten miles south-east of Nonsuch Island; 700 fathoms; standard length 27 mm.*

Field Characters: An oval fish; translucent, bluish white outer balloon skin; fins, lips and eye-sockets white; eye well-developed; teeth moderate; illicium bulb and mental barbel just through epidermis; sphenotic, quadrate and mandibular spines clearly visible; anus sinistral.

General Measurements and Counts: Total length 35.7 mm.; standard length 27 mm.; depth 18.8 (in length 1.4); depth, inner body 10 (in outer depth 1.8); head 15 (in length 1.8); eye 1.7 (in head 8.8); snout 4 (in head 3.75); maxillary 5.7 (in head 2.6); pectoral 14; pectoral length 2.8; dorsal 3; dorsal length, total 7.1, external length 21; anal 3, total length 7.1, external length 28; illicium stem and bulb 2.8; bulb diameter .8 mm.

General Description: External profile an almost regular oval, dorsal and ventral surfaces equally curved; snout drops almost vertically to lip; eye large, well-developed, the only black tissue about the fish, the eyeball bluish black, iris with silvery spicules, densest below, dying out on the outer half of the sides and the top; nostrils a little nearer apex of snout than eye, both openings very small and on the summit

of a long, thin narial stalk arising from the skull proper, at the same vertical as the illicium stem; mouth moderate, the gape reaching to mid-eye, slanting up 20 degrees.

Teeth: At the premaxillary symphysis there is a deep bay, the inner rim of which is lined with two teeth; along the outside are four or five very small, straight teeth; along each half jaw are 18 to 20 inwardly curved teeth, the anterior ones largest; some of these are arranged in double rows hinting of the several oblique lines in the adult, and five or six are obviously replacement teeth, each ready to take the place of its companion when it falls out.

The teeth in the lower jaw are very similar to those in the upper, except that there are only three anterior, small straight teeth, there is no symphysial bay, and the anterior three or four pairs of canines are larger than any in the upper jaw. The velum within the upper jaw is so wide that the roof of the mouth cannot be seen.

The outer skin is smooth and covered with an infinity of minute black dots which gives it a grey appearance. Along the sides of the head and body is a sparse scattering of numerous, small, dark, dendritic chromatophores, which die out gradually at the vertical of the eye and gape, the anus, and the dorsal and ventral outlines. They are thickest around the gill-openings. Of the internal body, the region of the eye, snout, post-brain, and whole vertebral body are unspotted white, with a few, large chromatophores on the side of the peduncle. The upper surface of the brain and the opercular region have many large chromatophores, and there is a black patch at the anterior base of the dorsal fin. The base of the coelom nearest the body is black, the ventral surface uncolored; the branchiostegals are clearly marked, dusky against a pale background. The sphenotic, quadrate and posterior mandibular spines are well developed but do not reach the surface of the outer epidermis. The internal vertebral body is of comparatively shallow depth, parallel-sided, with the bases of the vertical fins prominent, with oblique posterior faces. The dorsal and anal have three rays, only two-fifths of which project beyond the outer skin, an amount quite insufficient for any natatory or balancing use. They emerge close to the caudal. The caudal has eight rays, the two outer small and not reaching the full length of the tail.

The basal bone of the illicium is strong, arises from the supra-occipital and extends forward flat on the skull, giving rise, halfway

between the eyes and the snout, to a short, stout, vertical stem. This enlarges into an opaque, roundish bulb, about a quarter of which projects in a large dimple, above the outer skin. From the middle of the throat of the external skin, directly beneath the eye and the posterior end of the gape is an external bulbous swelling about the size of the illicium bulb. This has a notched cap over the summit, and it has no visible tissue connecting with the internal chin or jaw or head. It is unquestionably the anlage of the mental barbel.

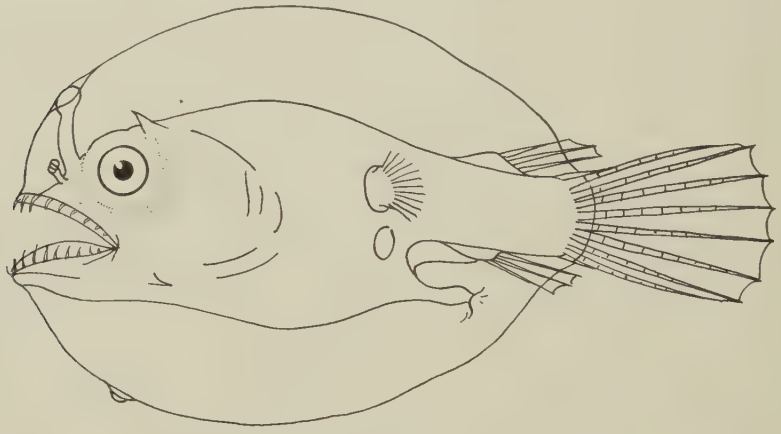

Fig. 24. *Linophryne arborifer* Regan. Post-larva.

Discussion: Owing to the balloon-like, inflated outer skin of this pediculate post-larva, the real fish within has direct contact with the outer world through only fourteen channels, mouth, two eyes, two nostrils, illicium, two gill-openings, anus, two pectorals, dorsal, anal and caudal fins. The remainder of the surface is more or less spongy or rubbery, almost transparent tissue, traversed only by a sparse network of white meandering nerves. The only actually normal sessile organ is the mouth which, as usual, is attached closely to the skull, with, of course, direct open contact with the water. The pneumatic outer skin meets at the lips, making the jaws and teeth usual in appearance. The adaptations of the other points of contact are as follows:

Eyes: In the normal position on the lateral aspect of the skull, but considerably beneath the external skin; contact is made by means of

an absolutely transparent pit, with flaring sides, roofed by thin invisible skin whose presence is revealed only by touch.

Nostrils: Both openings are close together on the summit of tall slender stalks.

Gill Openings: Small and round at the summit of hollow tubes.

Anus: Sinistral, at the end of a long, slender, intestinal tube.

Pectoral: Half of the fleshy base is subdermal.

Dorsal: Three-fifths of the ray lengths are subdermal.

Anal: Three-fifths of the ray lengths are subdermal.

Caudal: One-tenth of the ray lengths is subdermal.

Late Embryo: In net No. 287 there came in the egg of a ceratioid. This is Number 11.509, and was taken July 11, 1929, nine miles south-east of Nonsuch, at a depth of 700 fathoms.

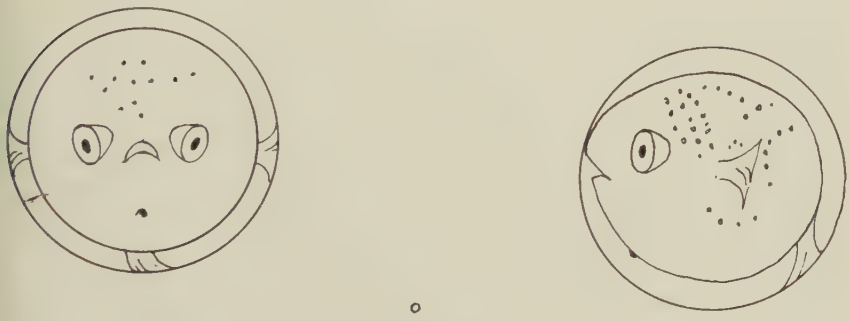

Fig. 25. *Linophryne arborifer* Regan. Late embryo; natural size in center.

The egg was round, 1.3 mm. in diameter and perfectly hyaline. It was almost filled with a fully-developed young ceratioid. The front view shows it in outline as round as the slightly larger egg, with two equally round eyes, directed well forward. It touches the inner wall of the egg shell at three points—the pectorals and caudal. The former are so big that they are bent over at the point of contact, and the tail fin is pushed downward and to one side, all braced hard against the little sphere. The lateral view shows in profile only two contacts—the snout pressed against the egg and the bent and depressed tail fin. I can detect no signs of vertical body fins. The inner, narrow body of the fish is translucent and the outer balloon skin is so thin and transparent that only in certain lights is it visible at all. Its general con-

tour on the head and sides is faintly indicated by a sparse scattering of pale blue chromatophores. There is no sign of an illicium, but the most significant character is a distinct dark spot, resolving into a slight elevation under high power, on the throat. A ceratioid with a mental barbel can be only a *Linophryne,* and so I choose to consider this as the earliest known stage of the only common species, *arborifer,* which we have taken in our hauls.

The points of greatest interest are the large size and forward direction of the eyes, the presence in the egg of the larval balloon skin, and the absence of a free-swimming larval stage. This fish would have hatched in a day or two with perfect post-larval outline, eyes and fins.

Linophryne brevibarbata sp. nov.
(Adult and post-larva)

Type: *Number* 11,656, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 308; *July* 16, 1929; *nine miles southeast of Nonsuch;* 900 *fathoms; standard length* 33 *mm.*

Field Characters: A stout, short-bodied ceratioid, black, with pale buffy fins, illicium and barbel; iris iridescent green; moderate sphenotic and short opercular spines; illicium bulb with short tentacle; barbel with three short, stout branches, each lined with five to eight blunt, finger-like processes, not extensible.

Measurements and Counts: Total length 44 mm.; Standard length 33 mm.; depth 22 (in length 1.5); head 20 (in length 1.65); eye 2 (in head 10); snout 4.8 (in head 4); maxillary 9.3 (in head 2.1); pectoral 16; pectoral length 4.3; caudal 8; caudal length 11; illicium total length 3.5; barbel total length 4.3.

General Description: Body nearly oval, the tail end broader; back and abdomen evenly curved, snout rather stout; eye large, iris brilliant green; nostril openings close together on a rounded tubercle arising on a large, conspicuous mound, on each side of the illicium base, and considerably nearer the tip of the snout than the eye; teeth much broken and worn, about six pairs in the upper jaw and nine or ten in the lower, several forming an irregular second row; the anterior teeth are larger than those behind; a pair of small vomerine teeth; the skin is black and smooth, and has a sparse network of several long, meander-

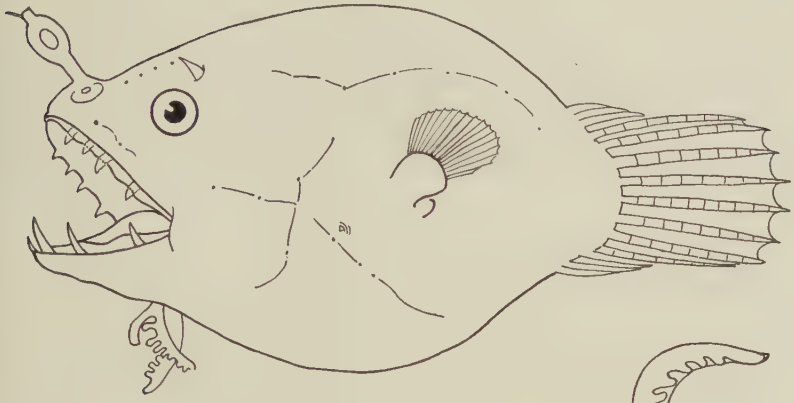

Fig. 26. *Linophryne brevibarbata* sp. nov.

ing, white threads, marked at intervals by round, glandular openings; the moderate sphenotic spine points obliquely forward, the small opercular spine is directly out at right angles to the body.

The dorsal and anal fins project beyond the skin only a short distance, and lie close to the dorsal and ventral base of the caudal; the rays are densely sheathed in thick epidermis; but they seem to number three in each fin; the pectorals of sixteen rays are well-developed, well back and are just above and partly over the gill-openings; the caudal is long and tumid, the eight rays being thickly encased in tissue.

The illicium stem is short and enlarges at once into a largish, oval bulb, translucent with a dark blue, oval core, and slightly frosted at the upper end; beyond this is a short stem which gives off a single anterior tentacle, and two posterior tentacles. The barbel is apparently full-sized, but quite unlike that of any other member of the genus; it consists of three short, stout branches, each lined on one side with five to eight short, thick tentacles, varying from low distal tubercles which grade into finger-like processes.

Post Larva: An immature specimen of this form of *Linophryne* is recorded as Number 18,535; Net 882; taken September 13, 1930; 10 miles South of Nonsuch; depth 700 fathoms; standard length 26.4 mm.

This larva was of the usual balloon-skin type, the outer skin finely vermiculated with dusky, but translucent; the dorsal surface of the inner skin of the head, and the opercular region coarsely dotted with large black chromatophores; an irregular band, several chromatophores broad, along the lower side of the inner vertebral body.

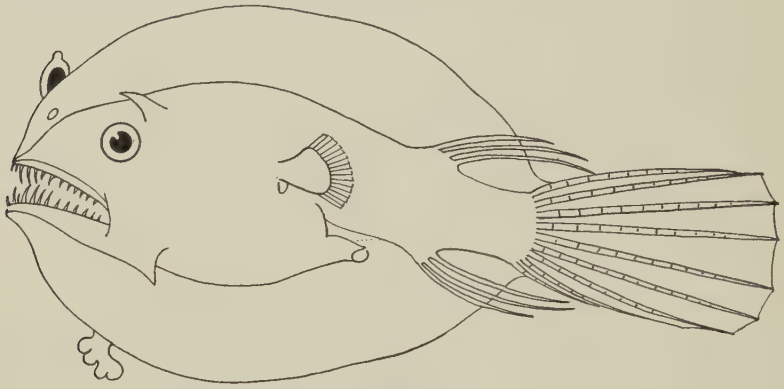

Fig. 27. *Linophryne brevibarbata* sp. nov. Post-larva.

The large bulb with frosted tip appears just above the surface of the skin, the inner blue core very large and conspicuous; a chin barbel shows the general shape of that of the adult, but is short, and with only a suggestion of the tubercles and tentacles; the anus is sinistral, the teeth are fairly even and more numerous than in the older specimen; in one-half of the upper jaw sixteen teeth, three anterior on each side very short and grouped closely together, a longer canine on each of the inner sides of the open symphysis. In a lower half jaw there are eighteen, in graded fives, set obliquely, several of which are probably replacement teeth.

In the cleared and dyed aspect, the vertebrae are seen to be slightly ossified, the jaws and caudal rays very strongly, and the opercular apparatus, the widely separated dorsal cranial bones, and the vertical fin rays with a medium amount of ossification.

Lophodolus lyra sp nov.

Type: *No.* 21,610, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1,111; *July* 27, 1931; *ten miles south of Nonsuch; Depth,* 800 *fathoms; standard length* 47 *mm.*

Field Characters: A small, dark brown ceratioid, with very large mouth and head, small eyes, and numerous teeth of small size. A short, thick illicium bears a dark ball at the tip with a terminal pair of snow-white, lyrate tentacles.

Sphenotic, quadrate, mid and posterior mandibular, and symphysial mandibular spines present. There are six dorsal and five anal rays, only four in each fin projecting above the skin.

Measurements and Counts: Total length 53 mm, standard length 47 mm; depth of head 19.3 (in length 2.4); head 20 (in length 2.4); eye .86 (in head 23.2); snout 5 (in head 4); maxillary 9 (in head 2.2); mandible 13.5 (in head 1.4); pectoral fin 18 rays, length 4.5 mm; dorsal 6; anal 5; caudal 9; illicium basal bone 4.3; stem 5.7; tentacles 4.3 mm.

General Description: The head of this fish is enormous, going into the length two and a third times. The dark brown skin covers all the fin rays. The head is strongly curved above, while the comparatively straight ventral outline is broken by the sharp posterior angle and spine of the mandible. The peduncle is thick and parallel-sided and the tail fin continues the same width.

The eyes are very small, going over twenty-three times into the head, but they are bright and functional; the nostrils are placed in a single, tubular tentacle, half-way between the snout and eye, the two openings placed respectively at the summit and half-way down the posterior side; the mouth is very large, with an enormous gape, and placed at a 35° upward angle.

Teeth: In the maxillary the teeth are very numerous and small; in one-half of the mandible there are about thirty teeth, half of which are twice as long as the rest.

Skin: The skin is smooth, while scattered over the body from snout to tail, in meandering lines, are numerous, small, flattened filaments, each ending in two distinct openings.

Spines: The sphenotic spines are very strong and large, the quadrate small, long and sharp, and the mandibular much shorter; the mandibular symphysis is extended downward into a single, compressed spine, and the infero-posterior angle of this bone is produced into a sharp spine.

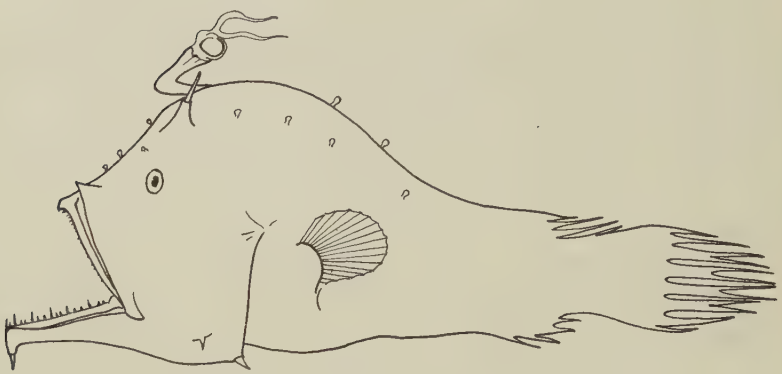

Fig. 28. *Lophodolus lyra* sp. nov.

The pectorals are placed about mid-body, the rays being 18 in number and 4.5 mm in length; there are four dorsal rays visible above the surface of the skin, set rather vertically and at the base of the peduncle; four anal rays, with the slightest suspicion of a fifth are arranged very obliquely along the ventral contour of the body. In several specimens of various ages, cleared and stained, six dorsal and five anal rays are visible, together with their muscular bases well below the surface of the outer skin. The caudal shows nine rays, the four central ones equally branched.

Illicium: This is well-developed but comparatively short and stout. Its total length is 14.3 mm. Much of the basal bone is sunken beneath the surface of the skin or in a deep trough or groove. Only the forward part is free, and elbows almost at once upward into the stem, still covered with the sepia-brown skin pigment. It immediately begins to expand into the transparent sphere which contains a large, opaque, black bulb. The upper third of this is powdered with silky white, forming a distal saddle of a tissue like silver snow, extending down in a short V in front. From this point there extend upward, from the very summit, two long, snow-white, lyrate tentacles, thick at the base, tapering rapidly.

Discussion: This ceratioid is not rare. I have taken about 40 specimens in my limited area of operation, from 600 to 1000 fathoms, more than half being in the 900 and 1000 fathom nets.

Melanocetus murrayi Günther
(Post-larva)

Specimen Number 21,516, *Bermuda Oceanographic Expedition, New York Zoological Society; Net* 1097; *July* 24, 1931; *ten miles south-west of Nonsuch; 700 fathoms; standard length* 9.3 *mm.*

Field Characters: A small, globular, pneumatic-skinned, buffy orange ceratiad, pectorals and caudal well-developed, about half of vertical fins projecting through skin; nostrils large.

Measurements and Counts: Total length 13.5 mm.; Standard length 9.3; depth 7.8 mm. (in length 1.2); depth inner body 5 (into length 1.8); head 5 mm. (in length 1.8); eye 1 mm. (in head 5); snout 1 mm. (in head 5); mandible total length 2.3 mm.; pectoral 15, pectoral length 1.4 mm.; dorsal 13; anal 4; caudal 11.

General Description: The external outline of the fish is almost circular, the outer epidermis coming into contact with the fish itself only at the mouth, nostrils, eyes, anus, illicium and fins. This pneumatic outer skin is transparent white, finely peppered with minute black chromatophores, giving it a pale bluish appearance. The anterior profile of the head is rounded steeply, being slightly broken by slightly protruding lips and the small mouth. The curve of the ventral profile, while almost circular is compressed and ends just in front of the anus. The base of the anal fin is oblique, and that of the caudal is vertical. The dorsal fin rays arise from the beginning of the even dorsal curve.

The inner body proper is rather oblong, opaque and a buffy orange becoming greenish on the head, and with considerable dark markings along the dorsal aspect of the trunk muscle bands and on the posterior abdomen. The smooth surface of the inner body is broken, first by the basal bone of the illicium, slender but distinct, which arises from between the eyes, slopes sharply forward and upward, and when near the outer skin over the vertical of the nostrils, sends a very short branch straight up to a pore on the mid-snout.

The eyes are well-developed, and the iris is bright, shining bluish above, and orange for more than the lower half. They are sunken deeply in the epidermal sockets, a normal condition at this stage, for the outer skin is raised considerably away from this part of the head. The nostrils are unusually large, their depth being slightly more than the diameter of the eye. The vision during this pneumatic stage must be rather limited, and the unexpected size of the nostrils is doubtless

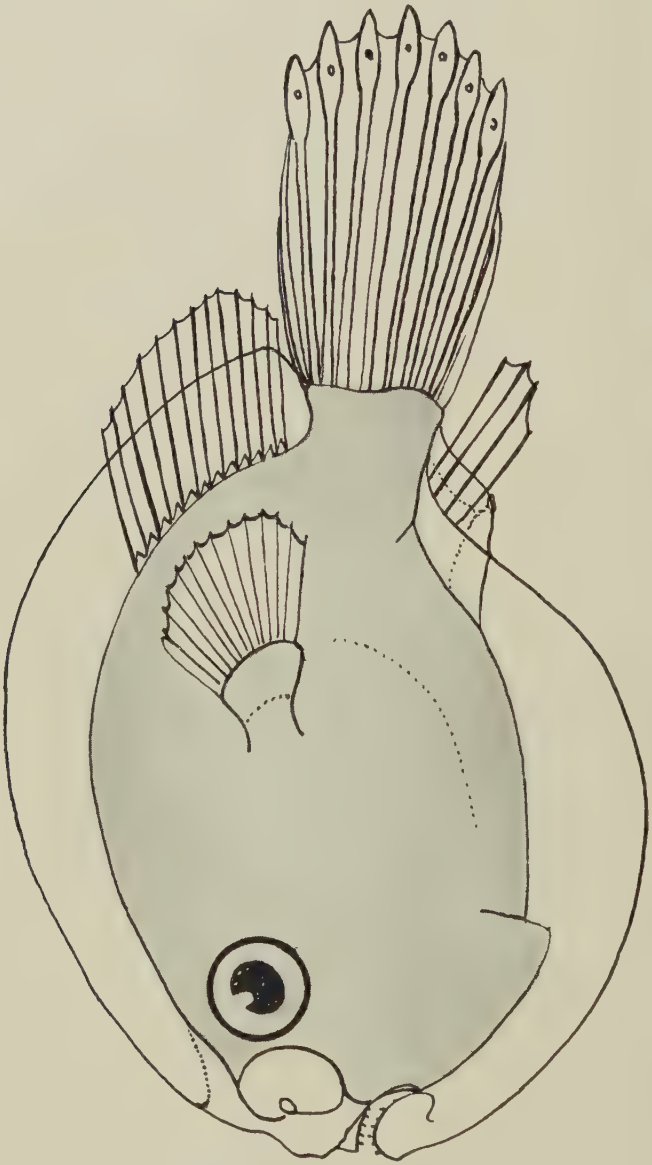

Fig. 29. *Melanocetus murrayi* Günther. Post larva, 9.3 mm. standard length.

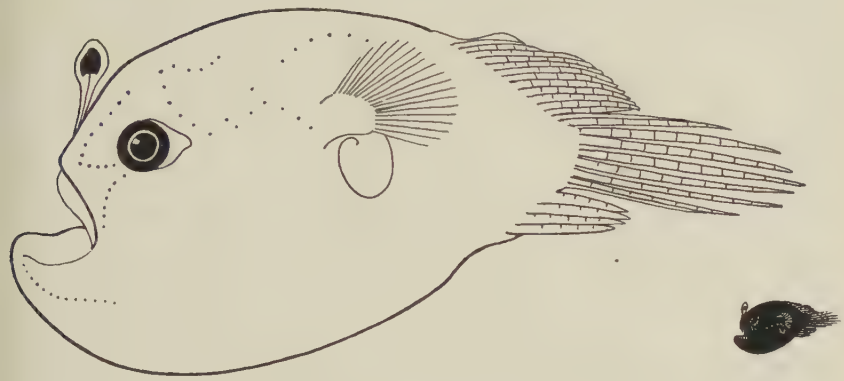

Fig. 30. *Melanocetus murrayi* Günther. Post-larva, 14 mm. standard length.

part compensation for this. The lips are noticeable; on the outside of both the upper and lower lips is a group of small, elevated glands, arranged in minute rosettes. The mouth as far as the aperture is concerned, is small, although the jaw bones are centered far back and down below the profile of the inner body, within the epidermal envelope. The teeth are numerous and minute. The anus is at the summit of a straight intestinal stalk, is median, and placed just before the anal fin.

The dorsal fin has a conspicuous, elevated base, the thirteen rays rising close together, the posterior very close to the caudal. The longest rays are 2.3 mm. long of which about 1 mm. is beyond the outer integument. Even the first protrudes into the open water. There are four anal rays.

Of eleven caudal rays, there are six which are full length, and the tips of these are somewhat spatulate, dead opaque white, with two knots of dark pigment in each. These are slightly but distinctly luminous in the fresh fish, being clearly discernible as a zone of light of indistinguishable color. The tips of the rays of the other vertical fins are whitish and opaque, but no glow was seen. The pectorals are well-developed, about a third of the fleshy base being out of the epidermis.

More commonly taken are specimens about one-third grown, of which No. 18,445 may be taken as a typical example. It came up in net Number 881, on September 12, 1931; ten miles south-east of Nonsuch, from 600 fathoms depth; standard length 14 mm.

The body is brownish black, dead black over the coelom, revealing here and there the dark bluish iridescence over the body cavity. The iris is dark blue with a sparse scattering of silver flecks. The eye socket is pale grey and the downward slant must allow much more of sideways and downward vision than in the adult stage. The illicium stem and bulb are free of the skin, and together measure 2.2 mm. The illicium stem is pale greyish, the bulb dark blue, terminal thickening pale. Nostril leaf tissue pale. The vertical fins dead white, with considerable basal black pigment, which extends a short distance up the rays and ends abruptly. The teeth are very small, scarcely visible above the lips.

Discussion: The ceratioid fish *Melanocetus murrayi* is not uncommon in our Nonsuch hauls. We have taken fifteen specimens up to 117 mm. in total length. Of these there has been a steady increase in numbers from 600 to 1000 fathoms, with June and July as predominant months. One other specimen of post-larva besides that described was taken curiously enough, on July 24, 1929, at 800 fathoms depth, the same depth and exactly two years before the one described above.

The changes from the post-larva to the adult are chiefly increase in size of teeth, complete reduction of pneumatic, dermal envelope, and the development and breaking through the skin of the illicium.

The greatest change in any one organ in ontological development is in the relation of eye to head, which is 5 in the post-larva, 6.4 in the one-third grown, and 24 in the adult.

Aceratias edentula sp. nov.

With notes on *Aceratias* in general.

Type: No. 20,751, *Bermuda Oceanographic Expedition, New York Zoological Society, June* 2, 1931, 1000 *fathoms depth, thirteen miles south-southeast of Nonsuch, Bermuda; Standard length* 19.6 *mm.*

This small, dark Ceratioid differed outwardly in no radical respects from the descriptions of *Aceratias macrorhinus.*

It was brownish-black, except for the lips and nostrils which were white. In standard length it measured 19.6 mm. while the 6.4 mm. of tail fin gave a total length of 25 mm.; the depth 5.7 mm. went into the length 3.4; the head 7.5 mm. into the length 2.6; the eye was 1.3 mm.

in diameter, into the head 5.7; the snout 1.8 mm., into the head 4.2 times.

The dorsal and anal fins each showed the very short tips of two rays, which barely appeared above the skin half-way down the peduncle. The caudal, covered like the rest of the body with black opaque skin, showed six rays. The sphenotic spines are well developed; the nostrils were strongly protuberant and of great size; the eyes were large, well-developed and telescopic, directed obliquely forward. This is the résumé of a careful examination of the fish, less than an hour after capture.

I had the fish cleared and stained at once by Miss Hollister (KOH Number 871), and within a week the opaque dermal pigment had been completely removed with ultra-violet rays, and it was satisfactorily transparent.

The bones showed complete ossification, and the most superficial examination revealed many unexpected characters. The dermal envelope, which was of considerable extent, had become perfectly hyaline, and the real body showed a depth of only 3.5 mm., a new relation to the length of about 6 times.

Instead of two dorsal rays we find six, the tips of four not reaching the external skin, and there are five instead of two anal rays. The six caudal rays visible in the fresh fish now become nine, four above and five below the mid-line. The lowermost takes no stain and is very difficult to see except at the very base where it is faintly pink. There are twenty vertebrae. The sphenotic spines are well developed.

There is a very thin, straight illicial basal bone identical in structure with the one I have described for *Haplophryne hudsonius** even to the presence of the minute particles of bone some distance back from the tip. It extends forward and obliquely upward from its origin in the center of the supraoccipital. The anterior end is flattened laterally and for a long time I could detect no terminal attachment. It seemed to end in mid-tissue. But by careful manipulation of light, a short column of unstained tissue, perhaps pre-cartilage, became clearly visible, extending straight upward and ending in a distinct epidermal pore. I gave the specimen to two of my assistants and in the course of ten minutes both had located and identified the entire illicium structure—

*Zoologica, Vol. XII, No. 2, p. 35.

the basal bone with its complex musculature, the slender colorless vertical stem and the open pore at the surface of the epidermis. The latter was quite invisible in the fresh specimen. The musculature (four pairs at least) of the basal bone is as powerful as in fish with an elaborate, free illicium which can be moved back and forth.

Parenthetically may I add that if the clearing and staining is done carefully and with constant readjustment to the type of fish, whether solid or flabby-fleshed, scaled or naked, structures such as the various body organs, cartilage, illicium stems, bulbs and pores are extremely easy to detect and to differentiate in great detail. Osseous tissue is only the more deeply stained and the more obvious of the bodily structures.

In this species at least, if not in the genus as well, this illicium stem, arising at the anterior tip of the basal bone, completely negatives the idea that the rostral denticle has anything to do with a vanished, anterior dorsal ray. When Parr propounded this idea I welcomed it gladly as accounting for the troublesome, new osseous structure at the tip of the upper jaw, but in *Aceratias* it seems we must look for some other explanation.

The superior rostral denticles are strongly developed, a median and two, lateral, large, curved fangs firmly implanted in a basal bony shield —shaped like a convex triangle with a deep curved bay between the two lower points. It has no close connection with any bone and only a very slight one with the rostral cartilage.

There is a remarkably radical modification of the upper jaw proper. The premaxillaries are closely opposed along the median line in a pronounced symphysis, but send out only very short, slender, lateral arms. In size, position and shape they resemble the premaxillaries of fish wholly unrelated to a Pediculate. The maxillaries are reduced to slender rods of bone which rise outside the mandible, about four-fifths of the distance to the quadrate, extend forward to within a fourth from the mandibular symphysis, and there end in short, two-pronged forks, the inner of which connects with the lateral arms of the premaxillaries. The upper jaw is therefore much shorter than the lower and modified out of all normal proportions.

The mandible is strong, deep and perfectly developed. It bears no teeth but has irregular nicks and two fairly deep scallops in the rim.

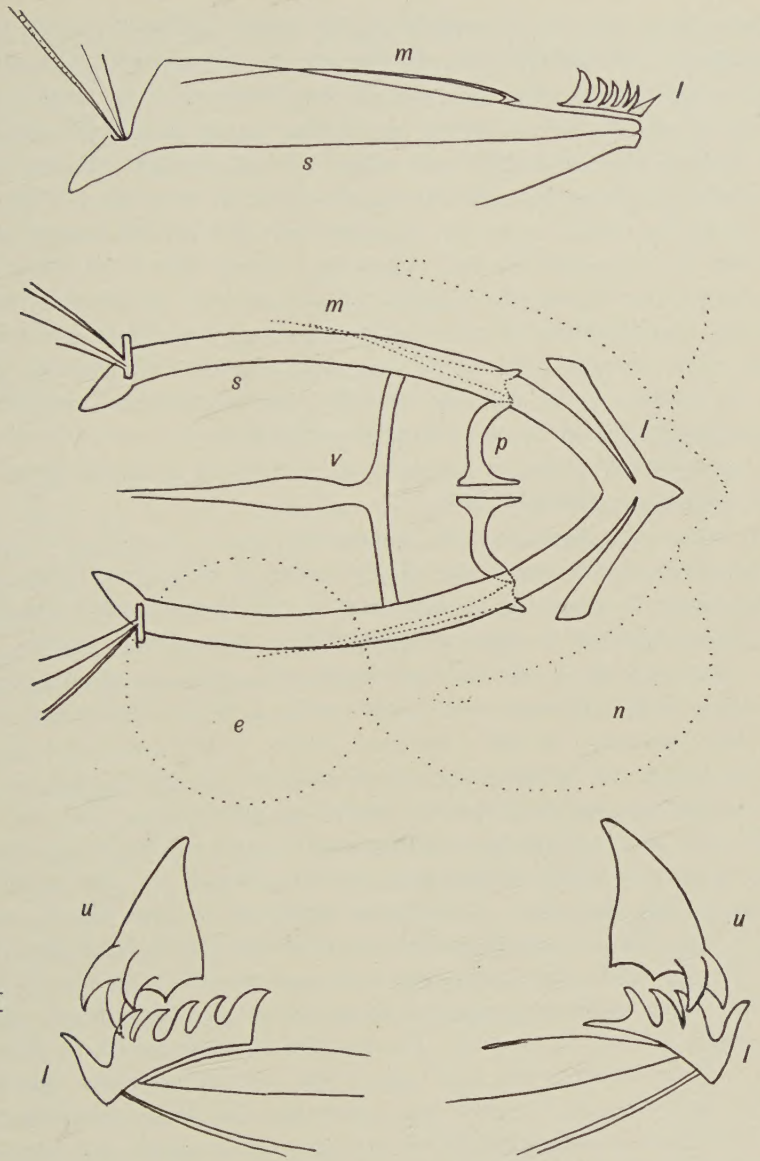

Fig. 31. *Aceratias edentula* sp. nov. Jaws.
I. Lateral view; II. Upper view; III. Right and left lateral views of rostral denticles.
u. Superior rostral denticles. l. Inferior rostral denticles. m. Maxillary. p. Premaxillary.
s. Mandible v. Vomer.

These latter fit into corresponding but much shallower curves in the maxillary. Arched over the anterior part of the mandible, and extending a considerable distance back of the symphysis is a large, angled bone, a solid base from which spring nine strong fangs, all sharp and curved, except the median one which extends straight upward. The central ones interlock with the superior rostral denticles. This bone with its nine teeth is quite free from the mandible even at the symphysis where they approach closest. Curiously enough this bone while quite unbroken and thoroughly ossified, is asymmetrical. It is slightly longer on the left side where it bears five teeth, than on the right which bears only three curved fangs. This bone, while it offers no absolute proof of the origin of the superior denticles, yet obviates the necessity of accounting for them by a connection with the dorsal rays, for there is no possibility of calling on the anal fin to perform a similar service for the mandibular denticle plate.

When we remember the astonishing spines, barbules, tentacles, photophore organs and scales in this order of fishes, the independent appearance of a pair of osseus plates is not unreasonable—structures doubtless intended to subserve some highly specialized function.

To check up on all the above details I have re-examined specimen Number 15,867, taken in Net Number 689, on June 9, 1930, at a depth of 1000 fathoms. It had a standard length of 15.8 mm., with a total of 24.3 mm. In the presence and development of the basal bone, illicium stem and epidermal pore it offered no differences. The jaws too were edentulous except for a solitary tooth on the mid-right mandibular ramus, very weakly developed. The remainder of the mandibles showed slight rugosities. The degenerate upper jaw was like the larger specimen. The two rostral denticle ossifications are so much like those of the other fish that they even share asymmetry. The three large fangs in the upper plate do not radiate evenly, but are turned, one to the right and two to the left. The mandibular plate has three teeth on the right and five on the left, exactly like that of the other specimen. Here again we are forced to the conclusion that those two structures have originated independently of any preceeding organ, and cannot be correlated with any definite structure in other groups of fish.

The suggestion of Parr seems very probable that these small Ceratiids are the free-swimming males which, according to Regan's

astonishing discoveries, sooner or later attach themselves, parasite-like, to much larger females. It is likely that not all the subsequent degeneration of osseous and visceral tissues takes place after the growing together of the two sexes. With this possibility, any hard and fast classification based on ordinary organs becomes a difficult matter. For example, according to the latest diagnostic table my specimens Number 20,571 and 15,867 line up as follows:

Telescopic eyes	Aceratias
Enormous nostrils	
Sphenotic spines	
Closed jaws	
Sub-dermal vertical fins	
Edentulous jaws	Rhynchoceratias

Other minor characters could be added, but these are sufficient to show how one or two additional specimens can upset preconceived ideas. I feel that any detailed view as to the evolution and exact relationships of these abyssal fish should wait for the examination of hundreds instead of individuals. Rather however than confuse the ultimate issue by assuming an amazing variation in a single species, I have chosen to reject the edentulous jaw condition as chief generic differentiation, and recognize the extremely degenerate upper jaw, etc., as of specific value.

Aceratias edentula differs from *macrorhinus* as described by Brauer in various proportions; the depth being slightly less, the head larger, the eye and the snout considerably smaller. The differences in dorsal and anal fin count is due probably to the subdermal character of these organs. *Edentula,* unlike *macrorhinus,* lacks all regular teeth on maxillary and mandible, and has the upper jaw degenerate, if not atavistic, while the rostral denticles and plates are strongly developed, three fangs on the upper and nine on the asymmetrical lower.